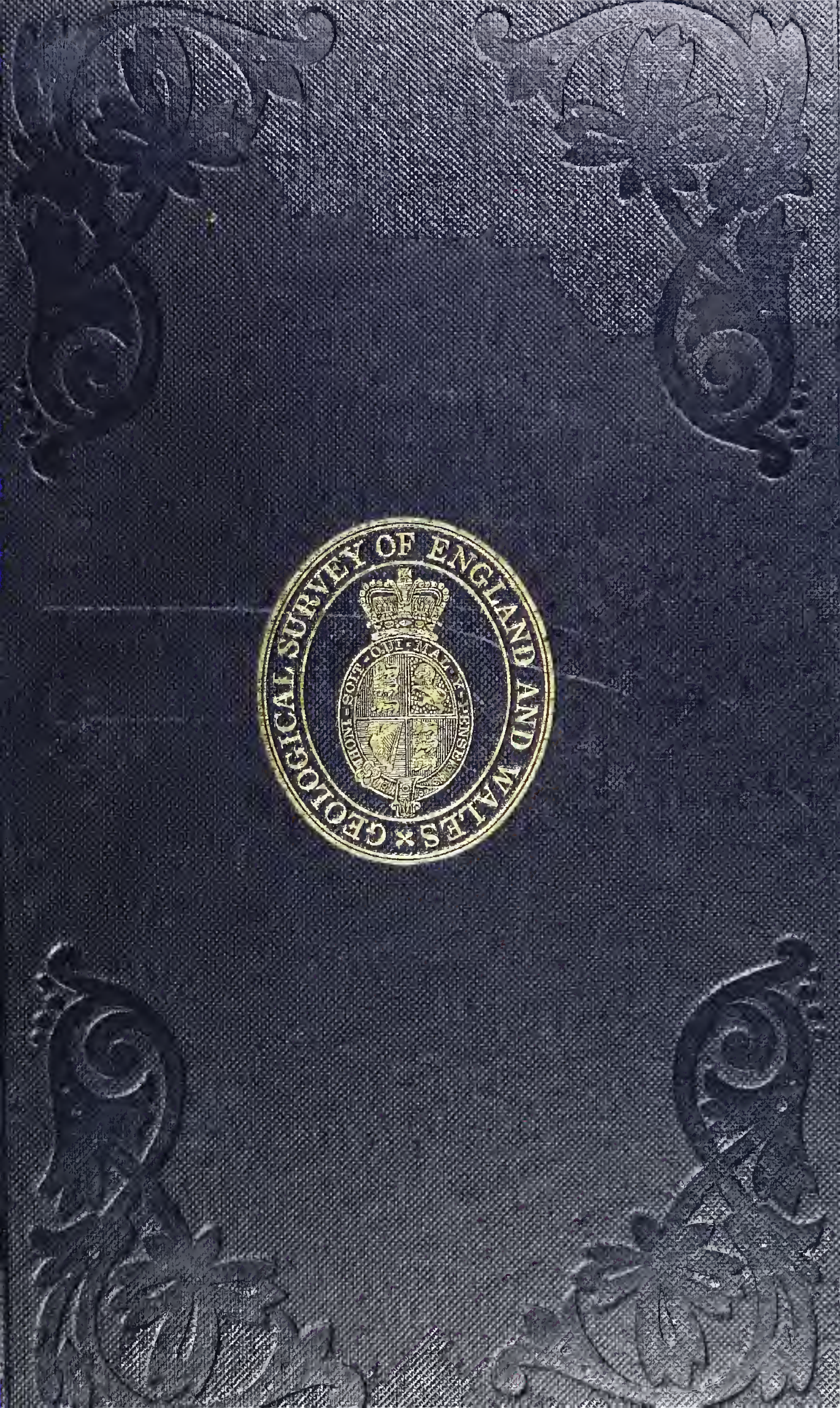
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MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

THE
WATER SUPPLY OF KENT.

WITH RECORDS OF SINKINGS AND BORINGS.

BY

WILLIAM WHITAKER, B.A., F.R.S.,

WITH CONTRIBUTIONS BY
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PREFACE.

THIS Memoir, dealing with the Water Supply of Kent from underground sources, is the largest of the series to which it belongs, but the author feels that there may yet be much to be added. The literature of Kentish Geology is so vast that it would be obviously impracticable to notice every published reference to the Water Supply of the County, and some details of importance may have been omitted. It is hoped that the publication of this Memoir may cause an inflow of fresh information.

Whilst passing it through the press some borings were deepened and notes of others came to hand. Sometimes this new information was too late for insertion in the proper place and so had to be added at the end of the book, as was also the case with newly-published matter, in the shape of extracts from, and notices of, books and papers, some of which are on matters of great importance.

There is often a difficulty as to names of places. These differ on the old and new Ordnance Maps and some names are absent on the one or the other. Many of the notes in this Memoir were written from the old map, which is still the geological one for nearly the whole of Kent, and it has not been thought desirable to alter all these to the new nomenclature. Sometimes, however, both old and new names are given. Other names, moreover, are to be found on the six-inch maps only.

Owing to the great amount of information given by deep sinkings and borings, Kent probably exceeds any other county in the number of its sedimentary formations and certainly does so in the range of these. Besides Pleistocene and Pliocene, at the top of the series, we have from Eocene to Silurian (with the omission of Permian), including the fullest development of the Cretaceous Series in the Kingdom.

The author, as is well known, took a large share in the original Geological Survey of Kent, and he has since added very much to our knowledge of the underground geology.

Our indebtedness to many engineers and well-sinkers will be seen from the frequency with which their names appear throughout the Memoir, which is one of a class that brings science and practice together for their mutual benefit. Dr. J. C. THRESH has furnished many detailed analyses made in his own laboratory and which are of especial value. The Local Government Board through Dr. H. F. PARSONS, have again rendered assistance by supplying copies of many analyses, etc. Prof. W. BOYD DAWKINS has given valuable detailed accounts of some of the borings in search of coal in East Kent; and Dr. H. R. MILL has contributed the important section on Rainfall.

The author desires to acknowledge the help of his son, Mr. H. L. WHITAKER, in the arrangement of some of the manuscript, in the correction of Proofs, and in making the Index.

J. J. H. TEALL,
Director.

Geological Survey Office,
28, *Jermyn Street, London.*
29th September, 1908.

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INTRODUCTORY.

Kent holds, perhaps, the most prominent position amongst our counties as regards water-supply from underground sources. It is a large county and its supply depends on underground water, except for the ever present houses and small out-of-the-way places that have to get water by storage of rain or from ponds, etc.

Truly there are many springs, but these are merely the outflow of underground water, and there once were small surface-supplies, as for instance at Sandwich, where the Delf stream was formely used; now nearly all public supplies and a great number of private ones, especially of manufactories, are derived from wells and borings, some of the small public supplies being from springs and some of the larger being supplemented by springs. The only approach to a river-supply is at Tonbridge, where water is got from shallow works close to the river.

Again, Kent contains the largest supply in the world that is got solely from wells, that established by the Kent Water Company, and now forming part of the undertaking of the Metropolitan Water Board. This great scheme has gradually spread eastward and southward from the old pumping-station at Deptford, until its area of supply extends far beyond the metropolitan boundary. This supply moreover is of such high quality that it is often taken as a standard of comparison for well-waters.

It will be of interest here to give a short notice of the progress of this great undertaking, and this may well be done from the "History of the Company" in SIR F. BOLTON'S "London Water Supply" (1) to which the reader is referred for details.

The Company was incorporated in 1809, when it was empowered to purchase the Ravensbourne Waterworks, established in 1701, and to supply Deptford, Greenwich, Lee, Lewisham and Rotherhithe. In 1811 Bermondsey, Charlton, Peckham, Plumstead and Woolwich were added. In 1857 the first deep well was sunk, at Deptford. In 1861 the works of the Plumstead, Woolwich and Charlton Co. were bought, and next year the Ravensbourne was abandoned as a source of supply, wells only being thenceforth used.

In 1864 the North Kent Waterworks Co. was amalgamated, and thereby the area of supply was extended to Bexley, Bromley, Chiselhurst, East Wickham, Eltham and Erith, and in 1868 the works of the Dartford Local Board of Health were bought.

In 1877 powers were obtained to extend the supply to Beckenham, Chelsfield, the Crays, Darenth, Eynsford, Farningham, Farnborough, Hayes, Keston, Orpington, Stone, Sutton-at-Hone, Swanscombe, West Wickham and Wilmington.

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[1] Ed. 2, *London*, 1888, pp. 57-59.

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From a later account, which also includes the above, we learn that in 1888 the powers of supply were extended to Brasted, Chevening, Cudham, Downe, Halstead, Horton Kirby, Lullingstone, Shoreham, Southfleet, Sundridge, and Westerham.(1)

The statistics of supply can best be taken from the statement prepared (by the Kent Co.) for the Royal Commission on London Water Supply (1897), revised to June, 1903 (for the Arbitration). The figures, which stand for average daily supply in gallons, have been revised by a deduction of 7 per cent. for slip of pumps, etc. Every year from 1839 to 1902 is dealt with, a modest beginning being made in the former with 334,800 gallons, whilst the highest record is 18,506,233 in 1901. From 1873 onward the highest figure in the maximum month is 21,005,910, also in 1901, and the highest in the minimum month 17,284,093 in 1902.

For the details of the figures the reader is referred to the original, the following is the general result:—

1839 to 1848	under a million.		
1849 to 1853	between	a million and two	millions.
1854 to 1857	„	two and three	„
1858 to 1860	„	three and four	„
1861 to 1864	„	four and five	„
1865, 1866, 1868 to 1870 ...	„	five and six	„
1867, 1871 to 1877	„	six and seven	„
1878 to 1880	„	seven and eight	„
1881 to 1883	„	eight and nine	„
1884	„	nine and ten	„
1885 to 1888	„	ten and eleven	„
1886, 1887, 1889 to 1890 ...	„	eleven and twelve	„
1891 to 1892	„	twelve and thirteen	„
1893, 1894 to 1896	„	fourteen and fifteen	„
1897	„	fifteen and sixteen	„
1895 to 1898	„	sixteen and seventeen	„
1899 to 1900	„	seventeen and eighteen	„
1901 to 1902	„	eighteen and nineteen	„

There were decreases on the figures of the year before in the following years: 1868, 1869, 1873, 1882, 1888, 1896 and 1902; but these were only slight breaks in the great increase.

The estimated population supplied increased steadily from 33,600 in 1839 to 632,184 in 1902, and the number of supplies from 5,600 to 105,364; but in both cases the same figures are given for 1876 and 1877, presumably from no calculation having been made for the latter year.

Constant supply began in 1873, when it was given to 2,000 houses, or 4·7 per cent., and it increased to 105,164, or 99·8 per cent. in 1902.

These statements are continued in the Annual Reports of the Water Board, from which the following figures are taken:—

On March 31, 1906, the number of supplies was 114,159, on March 31, 1907, 116,385.

The population supplied on March 31, 1907, the latest record, was estimated at 680,980.

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[1] R. Comm. Metrop. Water Supply. Appendices, 1893, p. 53.

According to the *First Ann. Rep. Metrop. Water Bd.*, p. 41, the average daily yield of the Kent wells in 1904 [? for the year ending March 31] in gallons was:—

Beckenham, given as Shortlands (2)	2,185,000
Bexley, given as Wansunt	1,312,000
Crayford (3)	2,719,000
Darenth	1,554,000
Dartford	157,000
Deptford (3)	3,123,000
Farnborough, "Orpington" (2) ...	1,953,000
Plumstead	500,000
Southfleet	880,000
Westerham Hill...	175,000
West Wickham	772,000
Wilmington (2)	3,635,000
Total	18,965,000

From the *Second Annual Report* we learn that in the year ending March 31, 1905, the average daily quantity supplied was 18,945,501 gallons, a very slight decrease.

In the *Third Annual Report* (p. 29) we are told that:—"In the Kent District constant supply is given throughout with the exception of some 300 services on Shooter's Hill, and this will be remedied by the water tower to be erected on the summit."

The *Fourth Annual Report* tells us that from April, 1906, to March, 1907, the average daily supply varied from 19,062,424 gallons in December to 22,560,418 in July, the average daily supply for the year being 20,270,093.

As an illustration of the economy of a well-supply the following list of the reservoirs of the Kent Works is interesting. It will be seen that all the reservoirs are small, storage not being resorted to in such a supply. The figures are from the statements above quoted and from the First Report of the Water Board:—

	Capacity in gallons.	High water-level, in feet, above Ordnance Datum.
Greenwich Park	1,125,000	158
Woolwich Common	1,500,000	248
Plumstead Common	650,000	170
Constitution Hill (Shooter's Hill)	500,000	320
Chiselhurst, Summer Hill... ...	450,000	315
Dartford Brent	370,000	130
New Cross, Telegraph Hill ...	1,750,000	163
Farnborough, Cowlan Hill ...	1,400,000	439
Knockholt, near the Beeches ...	500 000	795
West Wickham	250,000	550
Eltham	3,000,000	240
Westerham, Squerryes Park ...	60,000	444
Westerham Hill	68,000	818
Sundridge Park	1,500,000	? over 306
Total ..., ...	12,923,000	

In the Third Report of the Water Board, for the year ending March 1906, there are said to be 17 reservoirs in Kent, with a total capacity of 15,123,000 gallons, that is less than a day's supply.

There are some points of general interest in this great system of well-supplies. In the first place the water is mainly got by means of wells and borings; but little recourse to galleries having been made, except for the purpose of connecting wells at some of the pumping stations. In the absence of this means of lateral extension underground, which may be regarded as the chief way of getting very large supplies from such a formation as the Chalk, we may say therefore that these, which taken together are our greatest works for getting water by wells, are really immature, undeveloped, and, so to speak, imperfect.

Secondly, it is curious that some of these works are of no great size, two of the list, on p. 3, being credited with a yield under 200,000 gallons a day, whilst another has so small a yield that presumably it was not thought worthy of entry. When standing by the picturesque old water-mill by the south-western part of the little town of Westerham it seemed almost absurd to think that one was looking at one of the pumping stations of the greatest water-authority in the world! I hear, however, and with some sorrow, that this little place, with its 10,000 gallons of water a day (for Westerham) is to be given up, as the Board can only keep it as half-yearly tenants. *Sic transit gloria aquæ.*

Thirdly, and, although it has nothing to do with Kent, the chance of noting it is not to be missed, the great Water Board with all its wide-spreading power, cannot supply its own offices! These are on the Savoy property, in the Strand, and therefore have to take the private supply from the well at the Savoy Hotel.

Although in the matter of depth of works Kent is not in the first place amongst the counties, yet it has many borings for water of great depth, four (Cliffe, Erith, Frindsbury and Maidstone) being over 1,000 feet deep, and others approaching the 1,000 (Boxley, Chatham, and Sheerness Dockyard, all over 950). Many others, moreover, are of great depth, and therefore the county is certainly prominent in this respect.

In the matter of lateral extension underground, as far as I know, the 3½ miles of galleries possessed by the Ramsgate Waterworks is the highest record, and, strange to say, several times the total length of galleries of the whole of the Metropolitan Water Board wells in the county.

In the Mid Kent Waterworks we have an example of widely extended supply. Mr. F. L. Ball, the Manager, tells me that the area of supply is about 190,000 acres (or 296 square miles) and that 85 parishes are included, the district ranging from Kemsing on the west to Barham on the east, and from Teynham on the north to High Halden on the south. Now indeed, the Company has gone beyond its title, and the term "Mid" should perhaps be dropped.

To Kent belongs the honour of producing the first paper in which a record of gaugings of the level of the water in many wells was made, showing the rise and fall of the water, as connected with the rainfall etc., and the variation in the depth to water as connected with the surface-levels.

On December 14, 1831, a letter from MR. W. BLAND, of Hartlip, to Prof. Buckland was read to the Geological Society "On the Influence of Season over the Depth of Water in Wells"; but an abstract only of it was published by the Society.(1)

Whilst feeling sorry that the credit of publication in full cannot be given to the Society, one also feels glad that the author (and Prof. Buckland) promptly took steps to give to the scientific public the details of the "Letter . . . recording a Series of Observations made by himself, on the Rise and Fall of Water in Wells in the County of Kent"; for though the title differs, the paper is the same.(2)

It will be of interest to notice the work of MR. BLAND in some detail.

He starts by saying that "During the last twelve years I have been induced . . to fathom the water in my well, of 140 feet deep, once every month. I have kept a correct account of these observations, as well as of others founded upon them; and conceiving the results to be rather new, I am prompted thus to intrude myself upon your notice."

His first table "exhibits the rise and fall of the springs in New Place well, from January 1819 to June 1831." This shows "that the depth of water is almost invariably greatest at and about the longest day, and as invariably least at and about the shortest day. Observing this I for more than one year ascertained the quantity of rain which fell in this neighbourhood and at the same time noted the quantity of evaporation." The second table "of the Weather, as observed at Hartlip" ranges from 1819 to 1829, and it "shows the quantity of rain to exceed that of evaporation by a few inches only."

"Conceiving that the example of one well was not sufficient evidence, I determined to examine others; and . . . I made a regular survey of a district of some miles in extent." The third table gives the result of this survey, along a line from Upchurch to Goudhurst, with records of the height above sea, depth to water, depth of water and soil or sub-soil, at 35 wells, springs, or streams. The fourth table gives the like information along a line from Sittingbourne to Harrietsham, with 20 records. The fifth table deals with a line from Rainham to Milsted, with 24 records, and all there are graphically treated in figures showing the surface of the country and the line of the springs beneath.

The sixth table gives "the variation of the depth of water in those Wells that were fathomed a second time, and at different periods of the years 1827 and 1828." The records

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[1] *Proc. Geol. Soc.*, 1832, vol. i., no. 27, pp. 39, 40.
Phil. Mag., 1832, n. s., vol. xi., pp. 88—96.

of the former year are in June and December, those of the latter in May and December.

From the information thus collected Mr. Bland is enabled to say "I am perfectly satisfied that any excessive quantity of rain influences the rise of the springs, and causes them to flow several feet higher after very wet seasons, than they have been observed to do for perhaps years before during those that were dry. Again, the rains, I believe, cause the springs to begin to rise earlier, if they have fallen in any considerable quantity; but the rule is not general: whereas the rising and falling of the springs is a general one."

In the last place he alludes to the height of the water above the sea-level, and says "this height accompanies the rise and fall of the great hills . . . the spring heads rise and fall with the hills, independent of the rising and dipping of the strata in the several formations."

This remarkable paper is then the precursor of many others from various authors who have ably discussed the subject of the levels of underground water.

It is of interest to learn, from a publication of 1885, that the Hartlip well "has recently been measured by Mr. Baldwin Latham, and the result shows that no material alteration has taken place, although the well has been deepened since the original measurements were taken."(1) One can readily understand how pleasing it must have been to Mr. Latham, who has himself done so much in recording water-levels in wells, to verify the work of his first predecessor.

In regard to the literature of underground waters, I believe that Kent easily takes the foremost place amongst the counties, as may be judged from the long list of works at the end of this Memoir.

Although Kent contains no very large town, except for the south-eastern part of London, using that term for places of not less than 100,000 in population, this is really owing to the way in which what is really one continuous mass of population consists of three contiguous towns, which in the nature of things should be one. Rochester, Chatham, and Gillingham combined have a population of more than 126,000, and I think that Strood, separated only from Rochester by the Medway, is not included in this. It may be of interest to note the population of the chief places, and the Registrar General has been kind enough to supply the following estimated figures for the middle of 1907. It is remarkable that the pride of place should fall to a town of late growth.

Gillingham	... 52,256	Bromley	... 31,159
Dover ...	... 48,837	Beckenham	... 29,960
Chatham	... 40,682	Ramsgate	... 29,791
Tunbridge Wells	36,143	Gravesend	... 29,452
Folkestone	... 35,081	Canterbury	... 26,208
Maidstone	... 34,585	Margate	... 26,063
Rochester	... 33,483	Penge ...	... 23,918
Erith ...	... 32,924		

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[1] *Quart. Journ. R. Met. Soc.*, vol. xi., No. 55, p. 218.

The figures for the following smaller places (over 10,000) are taken from the Municipal Handbook for 1908 for the first five, the other three being the Census returns of 1901.

Dartford	... 23,036	Ashford...	... 13,600
Sheerness	... 20,000	Northfleet	... 12,906
Bexley ...	... 16,500	Faversham	... 11,290
Tonbridge	... 14,697	Deal ...	... 10,581

Kent therefore contains several towns of importance, and amongst them sea-side resorts, such as Dover, Folkestone, Ramsgate and Margate, places which have a very large accession of population in the summer-months, when they need a vast increase to their normal supply of water.

The problems of public water-supply are then well to the front, and, moreover, there are many large private supplies.

For the reasons given above we may fairly accord to Kent the place of champion county in the matter of water-supply from underground sources, and because of this it has been all the more difficult to deal with it. I trust, therefore, that defects in this Memoir will be forgiven; but I hope at the same time that they will be duly notified and that additional information will flow in, so that corrections may be made and further details may be published, either in a Supplement or in a new edition.

GEOLOGIC FORMATIONS.

Kent rejoices in varied scenery, and therefore also in a considerable number of geologic formations. No less than 27 divisions are marked on the maps, and were it not that the re-survey has but just entered the north-western corner of the county there would be more, as the Chalk would be divided into Upper, Middle, and Lower.

Kent is chiefly a Cretaceous county, that great Series being well developed, and some of its divisions having been named after Kentish places; Tunbridge Wells being used for divisions of the Hastings Beds; Folkestone, Sandgate and Hythe for divisions of the Lower Greensand, one of which already had the local name of Kentish Rag.

The name Cantian has, indeed, been proposed for the whole formation.

There is also a considerable tract of the older Tertiary beds, and the lowest member, the Lower London Tertiaries, is best developed in Kent, so that its three divisions all have Kentish names, from Thanet, Woolwich, Oldhaven or Blackheath.

Of the Pliocene there are some small tracts of sand, far away from the mass of the Series, many miles on the other side of the Thames.

The Pleistocene beds cover a large area on the whole, resting irregularly on various divisions of the Tertiary and Cretaceous Series; but though wide-spread they are thin, whilst the older beds are thick, and especially the Cretaceous. Amongst these there are no representatives of the Glacial Series, so far as we know, though some of the Hill Gravel may turn out to be as old as some of the Glacial Drift of other parts.

The following tables show the order of succession, and the classification of the various stratigraphic divisions found in the county, the detailed column on the right giving the names of those divisions which are shown on the Geological Survey Maps, down to the base of the Ashdown Sand, the lowest outcropping division in the county, from which there is an unbroken succession upward to the Bagshot Sand, whilst deep borings show what seem to be a fairly continuous Series underground down to the Trias.

Geological Formations occur at the Surface and are shown on the Geological Survey Maps.

	Recent		Blown Sand.
			Shingle.
			Alluvium.
Pleistocene	River or Valley Drift		Loam or Brickearth Gravel and Sand.
			Hill or Plateau Gravel.
	Over the Chalk. ? Of various and doubtful age		Loam.
			Clay-with-Flints.
	Pliocene		Lenham Beds.
Eocene Tertiaries			Lower Bagshot Sand.
			London Clay.
	Lower London Tertiaries		Oldhaven or Blackheath Beds (pebbles and sand).
			Woolwich and Reading Beds (clays, loams, sands and pebbles).
			Thanet Beds, or Sand.
Upper Cretaceous			Chalk (undivided).
	Selbornian		Upper Greensand.
			Gault (clay).
Lower Cretaceous	Lower Greensand		Folkestone Beds (sand).
			Sandgate Beds (clayey).
			Hythe Beds, or Kentish Rag (sand and stone).
			Atherfield Clay.
			Weald Clay.
	Hastings Beds.	Tunbridge Wells Sand	Upper Tunbridge Wells Sand.
			Grinstead Clay.
			Lower Tunbridge Wells Sand.
			Wadhurst Clay.
			Ashdown Beds, or Sand.

To the above may be added the following, which, though they do not come to the surface in Kent, have been found by borings to occur underground:—

Hastings Beds	Fairlight Beds.
Upper Jurassic	Purbeck Beds.
	Portland Beds.
	Kimeridge Clay.
Middle Jurassic	Corallian Beds.
	Oxford Clay.
	Kellaways Beds.
Lower Jurassic	Bathonian, or Great Oolite.
	Bajocian, or Inferior Oolite.
	Lias.
	Trias (Dolomitic Conglomerate).
	Coal Measures.
	Devonian or Old Red Sandstone.

WATER-BEARING BEDS.

We now come to the consideration of those members of the above-given succession of geologic divisions which are notable for yielding water, either from their general permeability or from being cut up by more or less vertical fissure-planes which allow of the inflow and passage of water.

Of course all geologic formations allow of the passage of water to some extent, or in certain parts; but we want now to omit those more or less clayey beds that sometimes yield small supplies, cottage-supplies as one may call them, and to treat only of those whose nature is in favour of water-supply rather than against it.

We will begin at the top of the scale and work downward.

Shingle.

Perhaps the most permeable of all deposits is to be found in the beach that fringes our coast. Where the pebbles and stones that compose it are more or less packed in sand, it is comparable to an ordinary gravel; but where the spaces between the stones are void of earthy material, or nearly so, we have an ideal gathering-ground for the downward percolation of water.

Kent possesses the largest tract of old shingle-beach in the country, namely Dunge Beach, the main part of which is about six square miles in extent, the parts to the west adding about another three. This great sheet is composed mostly of open beach, on which vegetation is very rare; here and there a blade of grass appearing. Rain therefore falling on such a tract can at once pass down; the only thing, indeed, to hinder it is the heat of the top pebbles in hot weather.

Fresh water is found wherever a hole is dug deep enough in the shingle and it is only along the outward fringe that the salt water of the neighbouring sea can get in.

Mr. Topley has made the following remarks: "The shingle-flats, which stretch out to sea at Dunge Ness . . are not destitute of fresh and good water. Wells are sunk through the shingle, and a supply of water is obtained which rarely or never fails."(1)

Gravel and Sand of the Drift.

We are not concerned here with the different ages or classification of the Drift gravels; all can be treated as one, a deposit of small stones, mostly flints, and pebbles, generally in a sandy matrix and often with beds of sand, forming as a rule a highly permeable mass. Being however of no great thickness, these gravels are useful only for small supplies, unless where they occur in the very bottom of a river-valley, where perhaps their water-contents may be reinforced from a stream. Tonbridge is, I believe, the only place of any size in Kent that gets its supply from gravel, though perhaps water from this source adds to the yield of many wells that are carried through gravel into beds below.

Lower London Tertiaries

This comparatively thin group, varying from about 100 to 150 ft. in thickness, is largely composed of permeable

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[1] 'The Geology of the Weald,' 1875, p. 353.

beds, more or less divided by others of a permeable kind. Sometimes, as in the eastern part of the county, it must be taken as a whole, there being no clayey bed to stop the downward motion of the water until the middle of the Thanet Beds is reached; there too, there ceases to be any practical division between the sand of the Woolwich Beds above and that of the Thanet Beds below. In the western and middle parts, however, the divisions are clear and the Woolwich Beds contain clayey layers that separate the waters above from those below.

The Oldhaven and Blackheath Beds consist, on the west, of masses of flint-pebbles in a sandy matrix and sometimes with layers of sand, whilst on the east, where they are somewhat thinner, they are of sand with a layer of pebbles at the base. In all cases the sand is very fine.

The Woolwich Beds contain layers of sand and of pebbles, and in the east are altogether sand of a coarser kind than that of the Oldhaven Beds.

The Thanet Beds are a fine compact sand on the west, whilst to the east a marly bed comes in. Sometimes there must be a fairly free communication between the Thanet Sand and the Chalk, so that the water in the latter may rise up, under pressure, into the former.

Mr. B. Latham says, in speaking of the water in the wells under London, as being derived from Thanet Sand: "A large proportion of the supply has been known for many years to pass directly in from the Thames in the neighbourhood of Charlton, where these Thanet sands come up in the bed of the river."(1)

The water of the Sheerness wells seems, to a large extent at least, to come from the sandy beds of the Lower London Tertiaries, and the like is the case at other places. As a rule, however, the outcrop is too narrow to afford a large supply.

The broad spread of the Blackheath Beds around Bexley Heath, Chiselhurst, Bromley and Beckenham, is the largest tract of these beds; but great parts of it are too much built over to allow water from surface-wells to be taken with safety. Moreover, the whole is within the area of supply of the Metropolitan Water Board.

Another large tract is that of the Thanet-Woolwich Beds between Sandwich and the Little Stour, where, of course, local supplies are got from these sands. Here however the supplies for Margate (from Wingham) and for Sandwich (from Woodnesborough) are likely some day to supplant private wells.

As the Lower London Tertiaries are the only division of the whole series, between the Drift and the Chalk, that forms a considerable surface, we may dismiss the Tertiary beds from consideration for anything but small supplies, except in a few instances.

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[1] *Journ. Inst. San. Eng.*, 1907, vol. xi., pt. 1, p. 8.

The Chalk.

We come now to the chief water-bearing formation of the county: nay more, to perhaps the chief one in the Kingdom, the New Red Sandstone alone having a claim to be its compeer.

The Chalk has the largest outcrop of any of the great geologic formations of Kent, and it occurs everywhere northward beneath the Tertiary beds. Moreover its thickness, which varies from about 640 ft. on the west to perhaps 800 ft. on the east, gives it a large storage-capacity.

By far the greater part of the outcrop is formed of the Upper Chalk; but the Middle Chalk, which crops out all along the great escarpment of the North Downs, probably too occurs at the surface some way down the main valleys, which breach that escarpment, namely those of the Darent, the Medway, and the Stour, as also in the dry head-parts of the valleys of the Little Stour and the Dour, and perhaps in some other dry valleys. The Lower Chalk has a still more restricted outcrop, as far as we know without the mapping of these divisions, being restricted to the lower part of the slope of the North Downs and to a shorter range down the main valleys than in the case of the Middle Chalk.

Although the Chalk as a whole is highly absorbent, yet water seems to pass through its mass somewhat sparingly. A greater quantity finds its way along the planes of bedding; but most passes along the more or less vertical planes of jointing so common in this and in other limestones. These planes generally occur along a dominant direction, and in the case of the Kentish Chalk, this is roughly from N.W. to S.E., as may be well seen in the Isle of Thanet, where the long line of cliffs lays the structure of the uppermost Chalk open to view, and where these master-joints, as they are termed, have considerable effect on the shape of the cliffs. There are also cross-joints which serve to connect the main ones and to facilitate the flow of water in other directions than that of the latter.

The Chalk, however, does not contain, as far as we know, sets of caverns, like those so common in the Carboniferous Limestone, wherein they sometimes give rise to underground streams. The joint-planes of the Chalk are not widely open, but form only very narrow fissures and often nothing deserving the name of fissure. Our one exception to this, at Strood, where a cavern or natural adit occurs and has been described in detail after this Memoir was written, is noticed on pp. 202—4.

Although in many places there may be fairly free communication for water from the top to the bottom of the Chalk, yet sometimes, from the occurrence of very compact beds or of clayey beds, there may be a separation into two or more water-bearing masses. For instance, where the division known as the Belemnite Marl is well developed beneath the hard nodular bed known as the Melbourn Rock, then there may be a division between the water of the Middle Chalk and that of the Lower, those beds marking the junction. In some districts, as near Hitchin, in Hertfordshire, springs are thrown out from the Melbourn Rock.

Whether or not there is much separation of this kind in the Chalk-waters of Kent, there is certainly one of another kind, dependent on the surface-conformation of the Chalk-tract. Besides the splitting up of that tract into various watersheds or basins, such as those of the Darent and of the Medway, the underground drainage of which is as distinct as would be that at the surface, were the Chalk impermeable, thus dividing up the Chalk into a number of separate water-districts from east to west, there is yet another such division which runs through the county, from east to west, dividing the Chalk into a broad water-area on the north and a very narrow one on the south. This division is formed by the dominant ridge of the North Downs, the highest part of the Chalk, from which northward water takes its course down the broad comparatively gentle dip-slope, whilst southward it follows the short sharp slope of the escarpment, at the foot of which there are often springs.

It should be understood, however, that whilst the underground watersheds agree on the whole with the surface-features, the two do not exactly coincide in their boundaries.

Each of the larger watersheds is subdivided, sometimes to a considerable extent, and there are many smaller watersheds, the streams of which have but a short course to the sea or to tidal water.

The chief watersheds or basins of the Chalk in Kent are as follows, from east to west:

The Dour Basin.—Wholly in Chalk, except for thin cappings of Drift, etc.

The Basin of the Little Stour.—A tributary of the Stour, chiefly in Chalk, with thin cappings of Drift in parts; but partly in Tertiary beds.

The Stour Basin.—Partly in beds below the Chalk, partly in Chalk, sometimes with Drift and partly in Tertiary beds. This river has a branch, the Wantsome, at the western side of the Isle of Thanet, the southern and western parts of which tract belong to the Stour system, whilst the north-eastern part is independent, draining to the sea.

The Medway Basin.—Chiefly in beds below the Chalk, but partly in Chalk with Drift, and partly in Tertiary beds.

The Darent Basin.—Also partly in beds below the Chalk; but largely in Chalk with Drift and partly in Tertiary beds.

The Basin of the Cray.—A tributary of the Darent, chiefly in Chalk with Drift, but largely in Tertiary beds.

The Ravensbourne Basin.—Partly in Chalk with Drift, and partly in Tertiary beds. Some of this tract is in the County of Surrey.

The first of the following tables of the areas of Chalk in various tracts is from an Appendix, by Mr. W. Topley, to the Report of the Royal Commission on Metropolitan Water Supply (1893). The figures stand for square miles and the arrangement of the districts has been reversed. The second is also from measurements made by Mr. Topley for that Report.

Tracts eastward of the District of the Metropolitan Water Board, except for the last, which is partly within that district.	Bare Chalk.	Chalk covered with		Total Chalk Area.
		Superficial Beds.	Outliers, spurs and edges of Tertiary Beds.	
North-eastern part of the Isle of Thanet	21	2	—	23
Basin of the Dour	14	14	—	28
Between the Basins of the Dour and of the Stour ...	20	3	—	23
Basin of the Stour, including the Little Stour ...	125	66	5	196
Basin of the Swale (really a collection of small streams which flow into the tidal channel, with independent valleys. W.W.)	27	49	10	86
The Medway Basin { East of the river ...	35	18	3	56
The Medway Basin { West of the river ...	19	7	3	29
Between the Basins of the Medway and of the Darent	28	11	10	49
Total	289	170	31	490

Tracts within the District of the Metropolitan Water Board.	Bare Chalk.	Chalk covered by		Total Chalk Area.
		Superficial Beds.	Edges and spurs of Tertiary Beds.	
Basin of the Darent ...	48¾ ?	10	?	—
Basin of the Cray, a tributary of the Darent ...	17	11	?	—
Basin of the Ravensbourne (partly in Surrey) ...	13 nearly	9½	4 ?	26½ ?
Total	78¾	30½	—	—

The small tract between the Basins of the Ravensbourne and of the Cray, which drains direct into the Thames, by small streams, has but a very small outcrop of Chalk, in separate patches, and may be disregarded.

Several years, however, before that Commission was appointed I had turned my attention to the question of the amount of Chalk-surface which was open to the absorption of water, and was led to make a set of maps for the consideration of the Metropolitan Board of Works, which was putting forward a scheme of special supply from the Chalk, partly in Kent. These Chalk Area Maps, as I called them, seemed to me so useful in correcting excessive estimates that had been made as to the area of the available gathering-ground of the Chalk, that I extended them considerably beyond the tract originally treated, as far indeed as the data then to hand enabled me, the limit being fixed by the completion of Drift Maps by the Geological Survey; and I also described the maps on various occasions (see *post.* Bibliography).

The principle of these maps, confined by the needs of the case (in the matter of Drift Maps) to the central and eastern parts of the London Basin, was to record the permeable or impermeable character of the beds that come between the Chalk and the sky, without any reference to geologic age or structure. At first sight this may seem a somewhat simple matter, but it will soon be seen that it is not so, being indeed often complicated.

The area over which Chalk occurs, whether at and near the surface or at considerable depths, was at once seen to be open to a threefold classification from the point of view in question, and it was soon clear that a fourth class of district must be added, another being subdivided later on.

Although the classification in question is sometimes settled by the formation at the surface, as shown on the geologic map; yet, over large tracts this is not so, and it is then that care has to be taken. Moreover, geologic formations are apt to vary in character, in permeability as well as in other ways, and this causes a good deal of difficulty in a work like that in question; a difficulty moreover only to be got over by compromise, a process somewhat dear to Englishmen (except perhaps to lawyers) and of which the third class of the following districts is the result.

Being now concerned with Kent only, we may deal with the facts presented by that county and with the five areas shown in it, thereby avoiding much of the difficulties above alluded to, which are not so greatly in evidence here as in some other parts.

1. *Areas in which the Chalk is Bare.*—This, of course, is simply taken from the geologic maps, and it is the only point of absolute agreement in the two sets of maps. Even here, however, there is some slight difficulty, for in places the soil over the Chalk may be unusually thick or more clayey than usual, and so may hinder the absorption of water into the Chalk. But this is a small matter. Again, the Chalk Marl, at the base of the formation, is often so clayey as to verge on the impermeable; were this separated, however, it would be seen to form only a very narrow selvage along the foot of the escarpment of the North Downs.

2. *Areas in which the Chalk is covered only by Permeable Beds.*—This, of course, includes beds that are almost wholly permeable, some of which may contain thin inconstant layers of an impermeable kind, such as the Drift gravels and sands,

which may occasionally contain clayey beds. In it are also included the Thanet Sand of western Kent, whereas the more clayey beds of that age in eastern Kent are not included. Of course, we are here dealing not simply with where there are permeable beds at the surface, but with where there is nothing but permeable beds over the Chalk.

3. *Areas in which the Chalk is protected by Beds of Mixed or Varying Character.*—Beds of this kind may come on next above the Chalk, as in the case of the clayey Thanet Beds of the east, or may overlie beds of the foregoing class, as in the case of the Woolwich Beds of the west. In both cases the overlying permeable beds are more or less cut off from contributing to the water in the Chalk, and therefore the tract of the highly permeable Blackheath Beds of the west comes into this division, except in those rare places where they may cut through the Woolwich Beds into the underlying Thanet Sand, an exception practically of small moment and which has to be ignored on the map. The various surface loams, whether those of the River Drift or those associated with the Clay-with-flints of the plateaux fall into this class, and it is important to note that the peculiar and irregular sheets of the latter class, however clayey they may seem, can hardly be classed as impermeable beds, for the wonderfully irregular way in which they rest on the Chalk, often filling deep pipes, is owing to dissolution of the Chalk by infiltrating water; these clayey sheets do not support streams, except for short periods during heavy rainfall. The Alluvium of the river-marshes is also included, as, though generally of a clayey nature, it is not wholly so, and, moreover, is sometimes very thin and so hindered from being a perfect cut off of water from getting below.

4. *Areas in which the Chalk is protected by Impermeable Beds.*—Whether these beds are at the surface or underlie other beds of a mixed or permeable kind is no matter: in both cases they cut off water from the Chalk; but in Kent this tract is limited to the parts where London Clay occurs.

It was found that this class of district needed division, as in many places the small streams pass over the London Clay and sink wholly or in part either into the Chalk or into the Lower London Tertiaries. This access of water to the Chalk from impermeable beds may take place by gentle soakage or by the aid of swallow-holes, in which the water is suddenly lost to sight. As will be seen further on there are many of these in Kent (see p. 47). Consequently this fourth set of areas was divided into the tracts that drained toward the Chalk, and which therefore might contribute to its water, and the tracts that drained away from the Chalk, and therefore did not contribute.

This fifth division of course occupies, in the Chalk Area Maps, the same position as benighted heathendom on a missionary map; but it cannot be converted.

The whole of the Chalk-tract of Kent has been treated in the way described and copies of the Maps of Chalk-areas can be seen at the Geological Survey Office, namely Sheets 1, S.W. and S.E. 3 and 6. The various areas have been measured in the last of these, of which but a small part, on the west, belongs to Surrey, and the measurements may be given as an illustration.

	Square miles.
Bare Chalk	137
Chalk covered only by Permeable Beds ... ... over	27
Chalk protected by beds of mixed or varying character, nearly	120
Chalk protected by impermeable beds ... ... over	38

The figures for 1, S.W. and S.E. are much smaller, and refer largely to Essex. I cannot find any for 3, which deals wholly with Kent.

Upper Greensand.

This division being of small thickness, of narrow outcrop and often absent in Kent is of no importance, hardly even for local supplies, but there are a few springs from it (see p. 42). The distinct outcrop reaches from the border of Surrey to the valley of the Darent, but beyond this nothing is seen, except for a possible slight representation on the coast at Folkestone.

Lower Greensand.

This is an important formation, being of considerable thickness, sometimes having a broad outcrop and occurring right through the county from the border of Surrey eastward to the sea, that is from Westerham on the west to Folkestone on the east. For present purposes the Atherfield Clay at the base may be neglected, or grouped with the unprofitable Weald Clay beneath.

Whilst water is often got from Lower Greensand by borings through overlying beds, it has been found that from its well-marked outcrop it thins northward, sometimes to the extent of totality. The records of deep borings show this very clearly, giving as they do thicknesses of the Lower Greensand much less than is found along the outcrop, where the total thickness has been estimated at 200 ft. and upward.

Thus, at Erith (Crossness), there is no Lower Greensand, and the like is the case westward, under London, in Surrey and Middlesex. At Chatham the thickness is 41 ft. at the Dockyard and 17½ ft. at the Water Works, if the base has there been reached.

Eastward of this we have no evidence until reaching the district between Canterbury and Dover, when, however, there is a good deal, chiefly from borings in search of coal. Whilst at Brabourne, near the outcrop, the thickness is 231 ft. (including the impermeable Atherfield Clay at the base, which is not separated in the account given) and at Elham

(Ottinge boring) a little further away from the outcrop it is 213, including as much as 102 of Atherfield Clay, in places still further from the outcrop it lessens greatly, as shown by the following figures which do not include the Atherfield Clay, except where noticed:—Barham (Ropersole boring) 51 ft.; Nonington (Fredville boring) 51 ft., perhaps including Atherfield Clay; Alkham (Ellinge boring) 39 ft.; Coldred (Waldershare boring) 70 ft., perhaps including Atherfield Clay; Dover Colliery, Hougham, over 82 ft.; Dover, Convict Prison, 31 ft.

Strange to say, however, at Margate, much further northward, and where one would have expected little or no Lower Greensand, a thickness of over 67 ft. has been found, without reaching the base. The evidence, however, on the whole is clearly against any expectation of getting a large supply of water in the northern part of Kent from deep-seated Lower Greensand.

The only part where such a supply has been got, by a number of wells, mostly private, is along the valley of the Medway, in which there are many successful borings, the depth to the Lower Greensand increasing of course down the valley, as the northerly dip is at a higher angle than the slope of the valley-bottom.

In part of Kent, especially to the east, this formation is practically divided, as far as water is concerned, the permeable Folkestone Beds being separated by the impermeable Sandgate Beds from the underlying permeable Hythe Beds. In other parts, however, the Sandgate Beds seem to be absent, or so thin as to be unmappable, and then there is little or no hindrance to water-communication between the two masses of permeable beds above and below; so that the Lower Greensand becomes one great water-bearing deposit.

Being mostly composed of sand (with some limestone and sandstone) except for the loamy or clayey Sandgate Beds in the middle and the Atherfield Clay at the base, this is a highly permeable formation, and therefore susceptible to surface-pollution. The best sites for getting a large supply of water are, of course, those which are removed from the risk of this danger, that is those where a protective covering of a less permeable nature occurs for some distance around. This condition is, of course, best found on the overlying Gault, which is an impermeable clay, and such a position has also the advantage of bringing the whole of the Lower Greensand from top to bottom within range of contribution, whether it be in the form of a single water-bearing mass or separated into two such masses by the presence of the Sandgate Beds in the midst.

The chief public supplies from this source are those of the wide-reaching Mid Kent Co., of Sevenoaks, of Ashford and of Hythe, as well as in part those of Maidstone and of Folkestone. Chatham too gets some addition from the Lower Greensand. Of smaller places, Westerham, Rainham, and Sandgate may be noted, the second of these getting its supply from a deep boring.

Hastings Beds.

We now reach the lowest water-bearing set of beds in the county, once massed under the name Hastings Sand. During the progress of the Geological Survey, it was found, however, that there were more or less definite alternations of sands and clays. The uppermost sand, which next underlies the Weald Clay, was named by Mr. Drew after the Kentish town of Tunbridge Wells; but the other divisional names have been taken from places in Sussex.

The Tunbridge Wells Sand, though generally forming one mass, is in parts of Kent divided by the somewhat local Grinstead Clay into two distinct sheets, and this, of course, has a bearing on its water; as with the Lower Greensand, it may sometimes form one water-bearing sheet, whilst in places it forms two more or less independent sheets. The sand is in great part very fine and compact, so that it is not likely to yield large supplies. The chief supply I believe is from a well at Hawkhurst, for the Cranbrook District Water Co.

This set of sands is everywhere separated by the Wadhurst Clay from the Ashdown Sand, a division which is more important from a water-bearing point of view, being often of a more open character. It gives a supply to Tunbridge Wells, from borings at Pembury, and a still larger supply is got in Sussex, in the Valley of the Brede, for the town of Hastings.

Mr. W. H. Maxwell, in describing the Tunbridge Wells supply, says of the Ashdown Sand of the district that it "consists of interstratifications of loam and clay. . The upper strata frequently appear as massive rock-beds, but from the borings it is found that the sandstone occurs in beds of a foot or two in thickness, with beds of loam or clay of about the same thickness between them. These intermediate clay beds must, to some extent, retard the free circulation of underground water."(1)

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(1) 32nd Ann. Rep. L.G.B., 1904, Supplement, p. 584.

THE RAINFALL OF KENT.

BY

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The accompanying rainfall-map is a reduction of a map prepared on the scale of two miles to an inch, showing the distribution of rainfall over the county as the average of 35 years' observations in the period 1868–1902. The data were collected for the most part by the late Mr. G. J. Symons, who founded the British Rainfall Organization, and they were published from year to year in "British Rainfall." The Croydon Natural History and Scientific Society has greatly stimulated the measurement of rainfall in a district which includes part of the North-West of Kent, but most of the observations upon which the map is based were made by isolated amateur observers who were interested in the work for its own sake, and a very large proportion of these records would have been lost had they not been sought out and published by the Editors of "British Rainfall." The number of complete rainfall-records extending over the whole period is considerable, and these served as standards for calculating the long-period averages of a much larger number of somewhat shorter records, so that altogether some 220 separate values were available for constructing the map.

In order to facilitate the calculation of the long-period averages corresponding to the shorter records, every year's rainfall at each of the 13 stations for which the 35 years were complete and at four others in which two or three years were computed from other records, was calculated as a percentage of the average at that station, and in this way a series of ratios was obtained which showed very clearly the fluctuations of rainfall from year to year. The ratio-stations were then combined in groups corresponding to the prominent geographical features of the county and surrounding districts, and the mean ratio for each group, together with the average for the whole series, are given in Table I. The last column of this table gives the best measure of the relative dryness or wetness of individual years over the whole county.

It will be noticed that nine consecutive years, from 1875 to 1883, had rainfall equal to or above the average, the mean excess being 11 per cent.; but that on no other occasion were there more than two consecutive wet years and in no case more than three consecutive dry years. Since 1888 there has been a nearly constant recurrence of groups of three years in which the first year was wetter than either of the following two. The driest year for Kent as a whole was 1898, when the deficit from the average amounted to 22 per cent., in 1901 the deficit was 20 per cent., while no less than seven years were drier than 1887, which was the driest year of the nineteenth century in most parts of the British Isles. The driest three consecutive years on record were 1900–1902, with a mean deficit of 13 per cent. The wettest year in the 35 was, as in most parts of the country, 1872, when the excess was 35 per cent., and 1877 came next. In 1903, however, which lay outside the period dealt with, the excess of rainfall calculated in the same way amounted to 32 per cent. After being reduced to the same period of 35 years, a period which may be accepted as yielding an average very close to the true mean, the records of rain-gauges which had been placed at a considerable height above the ground were corrected so as to be in accordance with readings taken at 1 foot. Very few cases occurred, however, in which this correction was necessary.

After the rainfall-figures had been placed on the map, isohyetals, or lines of equal rainfall, were drawn at intervals of 2·5 inches, and it was found possible to delineate these in great detail. In a few cases where observations on the higher ground were lacking it was necessary to draw the lines according to the analogy of those in neighbouring districts of similar configuration where sufficient observations existed. In every case where the lines were drawn without complete observational justification they are discontinuous.

The areas between the isohyetals were measured by the planimeter, the mean rainfall of each zone, or portion of a zone separately measured, was calculated and the average general rainfall for the county deduced as shown in the following table:—

Zone.	Square Miles.	Per Cent. of Total Area.	Mean Rainfall of Zone.
Below 20·0 inches	12·4	0·8	19·8 inches
20·0 to 22·5 ,,	143·2	9·4	21·6 ,,
22·5 ,, 25·0 ,,	302·2	19·7	23·8 ,,
25·0 ,, 27·5 ,,	394·6	25·8	26·4 ,,
27·5 ,, 30·0 ,,	488·1	31·8	28·7 ,,
30·0 ,, 32·5 ,,	142·6	9·3	31·1 ,,
32·5 ,, 35·0 ,,	39·6	2·6	33·1 ,,
Above 35·0 ,,	9·5	0·6	37·0 ,,
Total	1,532·2	100·0	

The general rainfall deduced from these figures is 26·8 inches, or, taking it to the nearest quarter of an inch, 26·75 in. Applying to this average the ratios in Table I. we get the following summary:—

1868-1902.	Mean general rainfall	26·75 inches.
1872.	Maximum general rainfall ...	36·10 ,,
1898.	Minimum general rainfall ...	20·85 ,,
1900-1902.	Driest 3 years, general rainfall	23·30 ,,

A comparison of the rainfall-map with the orographical and geological maps shows a remarkable correspondence between the three. The configuration of Kent follows the geological structure so closely that it is only necessary to consider the former in relation to the rainfall. The driest district is the flat margin of the Thames Estuary and Sheppey, where a mean rainfall under 22·5 inches is general, and a few square miles have even less than 20 inches. The gradual slope from the Thames southward towards the North Downs has less than 25 inches, the isohyetal of 25 corresponding roughly with the contour-line of 300 feet of elevation above sea-level west of the Medway and with elevations from 200 to 250 feet east of that river. The low rainfall follows the Medway Valley southward (through the gap in the North Downs near Maidstone) and a small portion of the Weald, near Yalding, receives less than 25 inches. The flat land of Romney Marsh has also less than 25 inches of rain, and the low ground between Romney Marsh and the Weald has only a little more.

The rainfall exceeds 30 inches in almost all parts of the county which are more than 500 feet above the sea. The isohyetal of 30 includes the whole length of the North Downs from the county-boundary on the west to the sea at Dover, broken only by drier strips in the gaps of the Darent and the Medway. It is remarkable that the gap of the Stour at Wye appears to receive as heavy a fall as do the surrounding hills. Between Wye and Dover the greatest extent of heavy rainfall occurs, including a small area with more than 35 inches to the north-east of Paddlesworth. The Greensand ridge south of Sevenoaks has also a rainfall exceeding 30 inches, and so has the district around Cranbrook, forming the eastern extremity of the Forest Ridges. Putting it broadly, the rainfall of Kent may be described as low along the Estuary of the Thames and on the north coast, comparatively high along the ridges of the North Downs and of the Greensand, and moderate in the plain of the Weald. *The higher rainfall occurs almost entirely on permeable rocks so that it is available for storage,* whilst the rainfall over the plains of impermeable clay is much lower.

In Table II. the mean rainfall is illustrated by the figures for a selection of the available stations so chosen as to represent all parts of the county; the small number of years employed for some of the computed averages was made necessary by the irregular distribution of the longer records.

Table III. gives the mean monthly rainfall for 35 years, or thereabouts, at five typical stations as nearly as possible equally distributed and representative of all parts of the county. The values are not corrected for height of the rain-gauge above the ground, but a supplementary table is given showing the monthly falls expressed as a percentage of the annual total, and these values may be taken as an accurate statement of the monthly incidence of rainfall over the county. This shows that at all stations the month of highest rainfall is October, and the average percentage for that month is more than 1 per cent. greater than the next wettest month. There is less unanimity among the stations with regard to the month of least rainfall. Three of the five stations favour April, which also gives slightly the lowest average. Of the two exceptions, one station gives March and the other May as the driest month; the difference between the three months March, April, and May are, however, so trifling that they may almost be considered as equally dry. It may be noted that the wettest station of the five considered shows the largest monthly variation, also that the variations of the stations nearer London are markedly less than the others presented in the table. It may also be noteworthy that the mean percentage of the three months June to August at the driest station (Greenwich) was found to be 5½ per cent. greater than the value for the wettest station (Acrise) for the same three months, this result probably being due to the larger disturbing effect of summer-thunderstorms upon stations having a low rainfall.

TABLE I.

Ratio of each year to the average, 1868-1902.

Years.	Northern Plain.	North Downs.	The Weald.	Forest Ridges.	East Kent.	Mean for Kent.
1868	100	104	99	104	99	101
1869	104	108	102	101	101	103
1870	78	85	82	85	81	82
1871	92	97	86	92	90	92
1872	127	137	134	140	139	135
1873	91	94	93	93	82	91
1874	81	92	88	88	77	85
1875	110	104	108	104	110	107
1876	102	105	106	110	103	105
1877	119	127	130	132	130	128
1878	114	104	113	115	110	111
1879	123	117	113	114	112	116
1880	121	116	113	116	115	116
1881	104	103	104	105	110	105
1882	113	112	115	114	115	114
1883	99	98	102	97	102	100
1884	82	80	81	83	85	82
1885	103	100	99	96	94	99
1886	104	109	110	110	109	108
1887	88	87	86	82	91	87
1888	106	100	103	107	95	102
1889	100	94	97	90	95	95
1890	94	94	96	95	93	95
1891	110	117	114	115	105	112
1892	108	98	100	96	118	104
1893	86	81	90	86	96	88
1894	122	120	121	119	122	121
1895	86	87	87	89	83	86
1896	99	103	105	100	113	104
1897	94	94	93	93	93	93
1898	80	78	77	72	81	78
1899	96	92	90	92	93	93
1900	99	99	99	103	102	100
1901	80	82	83	79	75	80
1902	85	82	81	83	81	82

TABLE II.

MEAN RAINFALL—KENT.

STATION.	Height above Gronnd. Ft.	Height above Gronnd. In.	Height above Sea-Level. Ft.	Period of Observation.	No. of years.	Arithmetical Mean. In.	Computed Mean, 1868 to 1902, for 35 years. In.	Computed Mean corrected for height above ground. In.
Dungeness	1	3	75	1885—1902	18	21·46	22·3	22·3
Hawkhurst, Sandhurst Rectory	1	3	208	1878—1902	25	28·74	29·3	29·3
Dymchurch	1	0	12	1874—1902	29	25·49	25·4	25·4
Hythe	0	6	12	1882—1902	21	27·35	28·0	28·0
Tenterden	1	5	190	1868—1902	35	27·96	28·0	28·0
Goudhurst, Scotney Castle	4	0	241	1873—1888 1891—1902	28	26·72	26·8	27·6
Tunbridge Wells, Bredbury...	1	0	415	1889—1902	14	29·48	31·5	31·5
Paddlesworth	1	0	612	1877—1902	26	38·35	38·2	38·2
Ashford Bethersden	3	0	111	1876—1902	27	26·70	26·6	27·1
„ Beavor Green	1	0	155	1874—1902	29	29·57	29·5	29·5
Staplehurst Park	1	0	73	1871—1879	9	31·01	28·7	28·7
Falconhurst, near Edenbridge	1	0	300	1868—1876 1878—1879 1881—1902	33	29·50	29·9	29·9
Hadlow, Golden Green	1	0	100	1896—1904	9	24·20	25·7	25·7
Linton Park	1	0	—	1890—1902	13	24·81	26·1	26·1
Lower Walmer, Meadowside	1	4	20	1884—1895	12	25·56	25·9	25·9
Chilham	1	0	331	1874—1881	8	32·01	29·5	29·5
Charing, Otterden	1	0	506	1868—1886	19	30·27	28·9	28·9
Harrietsham, Stede Hill	2	6	620	1893—1896	4	30·35	31·0	31·5
Sevenoaks, River Hill	4	0	535	1868—1902	35	27·31	27·3	28·1

TABLE II.—(*cont.*)

MEAN RAINFALL—KENT.

STATION.	Height above Ground.		Height above Sea Level.	Period of Observation.	No. of years.	Arithmetical Mean.	Computed Mean, 1868 to 1902, for 35 years.	Computed Mean corrected for height above ground.
	Ft.	In.	Ft.			In.	In.	In.
Knockholt, Kent Water Works	1	0	785	1889—1902	14	28·25	29·9	29·9
Wrotham, The Elms	1	0	418	1884—1886	3	26·51	27·5	27·5
Sheldwich	1	0	249	1872—1880 1882—1902	30	29·09	28·9	28·9
Canterbury, Harbledown	1	6	165	1879—1892	14	26·17	25·4	25·4
Detling, The Croft	1	2	336	1885—1902	18	26·48	27·8	27·8
Stourmouth	1	0	12	1868—1882	15	25·23	24·1	24·1
Sittingbourne, The Bank	1	1	38	1870—1877 1879	9	23·90	23·3	23·3
Herne Bay, Eddington	1	0	4	1884—1890 1892—1902	18	21·67	22·7	22·7
Margate, Apsley House	1	0	84	1881—1902	22	22·48	23·0	23·0
Sheppey, Leysdown	1	2	47	1885 1887—1902	17	20·49	21·3	21·3
Rochester, Knight's Place	2	6	320	1878—1902	25	25·47	25·6	26·0
Bromley Common	1	3	280	1868—1881	14	29·71	27·4	27·4
Dartford, The Downs...	2	4	162	1868—1879	12	23·05	22·3	22·6
Gravesend, Park Place	1	0	24	1883—1894	12	20·40	20·4	20·4
Higham...	1	2	25	1890—1902	13	18·37	18·8	18·8
Hoo St. Mary	5	6	146	1883—1902	20	19·96	20·5	21·4
Greenwich Observatory	0	5	155	1868—1902	35	23·60	23·6	23·6

TABLE III.

MONTHLY RAINFALL.

Month.	Tenterden.					Acrise. 1871-1902.				
	Mean monthly Fall.	Maximum Fall.	Year.	Minimum Fall.	Year.	Mean monthly Fall.	Maximum Fall.	Year.	Minimum Fall.	Year.
	In.	In.		In.		In.	In.		In.	
January	2·36	6·56	1877	·31	1880	3·25	8·38	1877	·28	1880
February	1·97	5·77	1900	·10	1891	2·71	7·23	1900	·26	1895
March ...	1·86	4·36	1888	·52	1893	2·53	4·84	1888	·65	1893
April ...	1·71	3·81	1878	·04	1893	2·22	4·41	1871	·00	1893
May ...	1·74	4·22	1878	·10	1895	2·12	5·25	1898	·18	1896
June ...	1·87	3·95	1896	·15	1895	2·35	5·45	1900	·39	1895
July ...	2·15	5·26	1894	·19	1885	2·72	7·80	1875	·23	1885
August ...	2·38	5·06	1878	·41	1885	2·97	5·94	1891	·93	1871
September	2·49	5·69	1896	·63	1895	3·17	8·19	1896	·34	1895
October...	3·42	7·62	1889	·30	1897	4·58	9·75	1880	·30	1897
November	3·05	6·65	1877	·58	1871	4·47	8·81	1872	1·22	1879
December	2·96	7·04	1868	·76	1873	4·14	8·87	1876	·74	1873
Year ...	27·96	37·90	1877	20·87	1898	37·23	47·51	1877	29·09	1871

Month.	Sevenoaks, River Hill.					Selling, Harefield.				
	Mean monthly Fall.	Maximum Fall.	Year.	Minimum Fall.	Year.	Mean. monthly Fall.	Maximum Fall.	Year.	Minimum Fall.	Year.
	In.	In.		In.		In.	In.		In.	
January	2·30	6·08	1877	·26	1880	2·51	6.97	1877	·24	1880
February	1·85	4·57	1900	·03	1891	2·04	6·08	1900	·03	1891
March ...	1·81	3·80	1897	·38	1893	1·97	4·36	1897	·46	1893
April ...	1·71	4·56	1878	·00	1893	1·80	3·61	1882	·02	1893
May ...	1·78	3·79	1872	·11	1895	1·86	4·41	1898	·20	1896
June ...	2·18	5·24	1896	·26	1895	2.08	3·79	1881	·23	1868
July ...	2·31	6·74	1888	·14	1885	2·24	5·69	1875	·22	1885
August...	2·23	4·53	1879	·63	1883	2·35	4·69	1892	·67	1899
September	2·42	5·64	1896	·32	1895	2·53	4·85	1896	·59	1898
October...	3·14	6·98	1880	·41	1897	3·49	8·23	1880	·43	1897
November	2·92	6·04	1877	·71	1901	3·20	6·95	1875	1·03	1871
December	2·66	6·30	1876	·52	1890	2·95	6·32	1886	·47	1873
Year ...	27·31	38·61	1872	19·29	1898	29·02	41·79	1872	22·78	1884

TABLE III.—(*cont.*)

MONTHLY RAINFALL.

Month.	Greenwich Royal Observatory.					Mean monthly Fall expressed as percentage of Annual Mean.					
	Mean monthly Fall.	Maximum Fall.	Year.	Minimum Fall.	Year.	Tenterden.	Acrise.	Sevenoaks River Hill.	Selling, Harefield.	Greenwich Royal Observatory.	Average.
	In.	In.		In.							
January	1·82	4·35	1877	·26	1880	8·4	8·7	8·4	8·7	7·7	8·4
February	1·52	3·82	1879	·05	1891	7·1	7·3	6·8	7·0	6·4	6·9
March ...	1·45	3·35	1897	·43	1893	6·7	6·8	6·6	6·8	6·1	6·6
April ...	1·57	4·31	1878	·12	1893	6·1	6·0	6·3	6·2	6·6	6·2
May ...	1·76	4·29	1878	·27	1896	6·2	5·7	6·5	6·4	7·5	6·4
June ...	1·88	4·57	1878	·21	1895	6·7	6·3	8·0	7·2	8·0	7·2
July ...	2·28	6·75	1888	·31	1878	7·7	7·3	8·4	7·7	9·7	8·2
August ..	2·24	5·38	1878	·35	1899	8·5	8·0	8·2	8·1	9·5	8·5
September	2·07	5·54	1896	·31	1898	8·9	8·5	8·9	8·7	8·8	8·8
October...	2·67	7·65	1880	·48	1897	12·2	12·3	11·5	12·0	11·3	11·9
November	2·20	4·00	1888	·57	1871	10·9	12·0	10·7	11·0	9·3	10·8
December	2·14	5·76	1876	·31	1873	10·6	11·1	9·7	10·2	9·1	10·1
Year ...	23·60	31·36	1879	18·05	1884	100·0	100·0	100·0	100·0	100·0	100·0

For information as to rainfall at Ashford, 1893 to 1906, see p. 78.—W. W.

SPRINGS.

Kent rejoices in springs, many of which are of importance. Most of them are caused in the usual way, by the water that passes down and through an overlying permeable bed being thrown out by an underlying impermeable bed, at or near the junction of the two, mostly on a slope.

Some, however, take their rise from the top instead of from the bottom of a permeable bed, where it is overlain instead of underlain by a more or less impermeable one. This happens where the junction of the two is in low ground, at the foot of a slope. The underlying permeable mass being saturated with water or getting less permeable in its underground course, becomes practically impermeable, and the water (from the higher ground of the outcrop) which cannot flow down beneath the ground has to escape at the surface.

Yet another kind of spring occurs along the courses of streams, where and when the surface of the underground water-plane rises up to the ground-level. These springs are associated with the phenomena of intermittent streams and will be noticed under that heading; we now deal simply with springs that depend on the relations between permeable and impermeable beds, and these will be noticed in stratigraphic order, beginning at the top of the series.

Some springs, of course, start at or near faults or sharp local disturbances, but I cannot call to mind any such in Kent.

As regards the yield of springs it must be remembered that this varies greatly, according to the season; it is, therefore, dangerous to assume that a large supply can be got from any set of springs unless records have been kept of the flow during a considerable time.

RECENT BEDS.

The *Blown Sand*, which occurs in two places along the coast, at The Warren, near New Romney, and at the Sand Hills that set in northward of Deal and thence trend northward nearly to the mouth of the Stour, is a very permeable deposit and must absorb rain readily. There must be an outflow of fresh water at various parts of the inland boundary of these spreads of sand, as is markedly the case with the deposit next to be noticed.

The *Shingle* that has been piled up by the sea in a succession of "fulls," as they are called, until a fairly broad tract has been made, is highly permeable; and where, as is usual, it has been deposited over Alluvium, which is more or less impermeable, the water is held in it and flows out along the inland edge; indeed, as the shingle is always at a low level, its highest parts being but little above the underground water-plane, it matters little on what it rests, the water cannot sink down deep in or below it.

Perhaps the most interesting illustration of this is given by the broad shingle-tract of Denge Beach, the inland edge of which is of an intensely serrated outline, spurs of shingle ofttimes spreading out far over the marsh. At the head of the re-entering angles there are springs of fresh water, which oozes out all around and may be found by scraping with the foot near the base of the shingle.

GRAVELS AND SANDS OF THE DRIFT.

Where these highly permeable beds rest on permeable beds water will of course pass through them into those underlying beds; but where they rest on a clay, as is often the case, the water will pass out at their edges.

Springs of this sort are mostly very small; indeed, I cannot call to mind any of notable size. Nevertheless, the water flowing out of large tracts of gravel must add appreciably to the volume of streams, as for instance in the district north of the Stour, in the neighbourhood of Canterbury, where there is much gravel over the London Clay.

Water from gravel is often ferruginous, as is sometimes clearly seen where it oozes out.

Mr. F. J. Bennett notices the occurrence of springs from the gravel over the Gault westward and south-westward of Kemsing, saying that "the water collecting in this gravel causes springs, with consequent slips in the clay: the slips thus formed are frequently filled in with a coarse material to allow a ready percolation of the water." (1)

The following account of a peculiar water found at a very slight depth at Canterbury may fairly find a place here.

Writing, presumably in 1707,(2) Dr. S. des Moulins says: "About twelve years ago a Mineral Water was accidentally detected in this city. In digging the Ground" the following beds were found:—

Fat black mold, gradually changing into the next	3
Earth, very fat and like butter, yellow, odour strong	2
Quicksand, with several little stones. Smell still stronger	2
Hard rock out of which water gushed with some violence.	

"They dug two wells at about 7 Feet distance from each other; one about eight or nine Feet deep . . reacheth the rock: T'other is not so deep by two Foot, and only toucheth the Sand.".

"The Water taken up at the Spring is extraordinary limpid, but grows something whitish in a quarter of an hour." From the description it was ferruginous and of an equable temperature.

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[1] Ightham: The Story of a Kentish Village, 1907, p. 5.

[2] *Phil. Trans.* 1708, vol. xxv., No. 312, pp. 2462-3.

EOCENE TERTIARIES.

The small tract of *Bagshot Sand* in Sheppey is unimportant; but the effect of water passing through it (including the overlying gravel) may be seen at the cliff eastward of Minster, where the springs from these permeable beds aid in the loss of land.

The sandy members of the *Lower London Tertiaries* have small springs, where clayey beds intervene; but here again none are important.

There are some springs in the broad tract of Thanet and Woolwich Beds round Ash, the clayey lower part of the Thanet Beds holding up the water in the sands above.

Mr. G. Dowker has remarked that "springs issue near the 'Sportsman,' [at Cliffsend, west of Ramsgate] and from the Thanet beds of Pegwell Bay cliff . . . apparently from the Tertiary beds."(1) One of the former is named St. Augustine's Well, on the Ordnance Map, and another is marked at Cottington Bridge, under the railway to the north-west.

Close to Faversham there is a spring in the large pond just south of St. Mary Magdalene Church, Davington; but this is likely to be of Chalk-water, coming up through Thanet Sand.

The same may be the case with the springs in the still larger pond at Davington Powder Mills, to the N.W. and with the spring feeding that pond, which rises just S.W. of it.

A little north-westward there seem to be springs from the sand of the Thanet Beds, a quarter of a mile east of Luddenham church, and about half that distance south of the church.

There is a funnel-shaped spring, apparently from a like source, nearly half a mile eastward of Teynham church.

It will be seen, from the account of Chalk-springs, that there is often doubt as to the origin of the water in these parts: one is in doubt, indeed, how to classify some of the springs at Tonge, Bapchild, etc.

Some powerful springs rise in the low ground of the outcrop near Newington, some way from where the Chalk comes to the surface. Prof. Hughes was therefore justified, at the time he described these,(2) in trying to account for them as Tertiary springs; but a later examination by Mr. Topley and myself, when we were expressly studying the springs of northern Kent, led us to conclude that the water, or at all events most of it, really came up from the Chalk, through the Tertiary beds, and these springs will, therefore, be noticed further on. The highest spring known seems to be of Tertiary origin (see p. 37).

At Gore, more than half a mile south of the church at Upchurch is a small spring, in Thanet Sand, a little below the 50 feet contour, giving rise to a little stream.

In the western part of Kent, where the Woolwich Beds nearly always contain distinct clayey beds, water is thrown

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[1] *Geol. Mag.*, 1887, dec. iii., vol. iv., p. 205.

[2] *Memoirs of the Geological Survey*, vol. iv., 1872, p. 392.

out from the overlying Blackheath Beds. This is especially the case over the large tract of the latter from Lessness Heath on the north, by Bexley Heath, Chiselhurst and Bromley, to Keston, on the south.

The springs between Erith and Woolwich have been described by Mr. Barlow and Prof. Ansted, who say: "At Abbey Wood station several springs are seen rising in the marshes," and "In the Plumstead Marshes, springs, yielding from 200 to 250 gallons per minute appear on the surface of the ground in the line of railway" (pp. 56, 54).[1]

At a visit by Mr. Topley, Mr. E. Easton and myself (1892), however we could see no strong spring. Moreover, springs eastward of Plumstead would not be from the Chalk, as was supposed by the authors quoted, for, at the time they wrote, little or nothing was known of the fault which throws the top of the Chalk to a level considerably below that of the marshes. The springs in question must be Tertiary springs, or at all events must rise through Tertiary beds, even if some of their water comes indirectly from the Chalk..

The springs found in the excavations for the piers at Greenwich,(2) would not be from the Chalk, as here, again, the Tertiary beds are faulted down.

THE CHALK.

It is from this formation that come the most important springs of the county, and these are divisible into two great sets. Firstly are those from the Upper Chalk, which occur to a large extent at or near the oncoming of the Tertiary beds, and which are the overflow from the great dip-slope of the Chalk to the south. Though these chiefly come from the top of the Chalk yet they are at a low level, belonging to the second class of spring noticed above (p. 28). Secondly are those from the Lower Chalk along the base of the North Downs, belonging to the first class and mostly at a fairly high level, and being the overflow of the narrow tract of chalk from the top of the escarpment to its foot.

The following description of the Chalk-springs and of some of those from the Eocene beds is taken from a statement prepared for the Royal Commission on Metropolitan Water Supply, (3) with many additions from later work, and some from older sources.

The notes were written, or compiled, after an examination of the district made during the months of November and December, 1892, with Mr. W. Topley, and for the most part also with Mr. E. Easton, for the especial purpose of considering the water in the Chalk. I was previously well acquainted with the country in question, having made the Geological Survey of the greater part of it.

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[1] *Proc. Inst. Civ. Eng.*, 1855, vol. xiv., pp. 56, 54.

[2] *Ibid.*, p 55.

[3] Report, 1893, Appendices, pp. 435-439, and 415, 416.

It should be understood that many small springs were not visited. The detailed notes are arranged from east to west, or from the coast to the neighbourhood of London, that being the general order in which the places were visited. It will be convenient, moreover, to treat firstly of the sea-bord, before taking up the two great sub-divisions noticed above.

Coast.

There are some powerful springs in places along the coast, chiefly from the Upper Chalk, which have often been described.

Mr. Topley has made the following remarks:—"The undercliff (known as The Warren) on the east of Folkestone, is mainly due to springs which issue from the Chalk near the top of the Gault. A gallery has been driven at the back of the undercliff to intercept the springs, and thus to prevent further slipping. A large quantity of water issues from the mouth of this gallery.(1)

The well-known spring at Lydden Spout, eastward of Abbot's Cliff, flows out several feet above the base of the cliff, from the lower part of the Lower Chalk. It was gauged, by Mr. Easton, on December 11th, 1892, when it was found to yield over three million gallons a day; but in summer the amount must be much less: indeed, other gaugings make it vastly less, Mr. H. E. Stilgoe recording as little as 148,609 gallons a day, whilst others vary from 1¼ million gallons a day upward.

We come now to consider the very interesting set of springs between Dover and St. Margaret's. My first contribution to the literature of these coastal springs was published in 1872,(2) though the observations on which it was based were made some years earlier, and is as follows:—"At the foot of the long range of Chalk cliffs countless springs burst out along the foreshore at low water, being dammed back as the tide rises. Where much fresh water is thus poured into the sea there is more green weed, the red and brown sorts seeming to prefer salt water."

On my working map (Sheet 3) it is noted that from the southern end of St. Margaret's Bay to the South Foreland there are many springs, at the foot of the beach and on the chalk foreshore, and that there are also some on the other side of the bay.

At our visit (1892) the springs between Dover and St. Margaret's were well seen. One set occurs on the chalk foreshore a little westward of the Convict Prison; a strong spring breaks out southward of the South Foreland High Lighthouse; others have been marked by the Ordnance Survey between there and St. Margaret's Bay; and a very powerful one occurs along fissures in the foreshore just eastward of Ness Point, the southern horn of the bay. In places, these springs were bub-

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[1] *Rep. R. Comm. Metrop. Water Supply*, Appendices, pp. 415, 416.

[2] *Geological Survey Memoirs*, vol. iv., p. 392, 1872.

bling up in a marked way; whilst in others there was a more gradual outflow. The total yield must be very great, and it simply runs to waste. Mr. Easton has since gauged three of the chief springs (December, 1892, and January, 1893), which together yielded more than 5 million gallons a day, that by Ness Point contributing $2\frac{3}{4}$ millions of this. Later measurements, according to Sir A. Binnie, give much less, from $1\frac{1}{2}$ to $1\frac{3}{4}$ million gallons.

Mr. H. E. Stilgoe has recorded the following figures, which stand for gallons a day:

Spring near Convict Prison, Dover	218,520
„ „ Ness Point	264,240
Springs near Frenchman's Fall ...	479,600 and 118,980
Spring near Gate's Hole	38,268
Springs near Canterbury Cave ...	70,497; 131,040 and 240,750

All but the first are from Upper Chalk, and the total comes to 1,561,905. It is clear therefore that the outflow of these springs varies greatly.

Along this line of coast there are many small faults, and the prevalent jointing (about N.W. and S.E.) is often clearly shown; the fissures thus produced probably determine the place of outflow of the chief springs.

Mr. W. H. Pendlebury says that "there are over 20 streams flowing down from underneath the chalk cliffs between Dover and St. Margaret's Bay" and, apparently accepting Mr. Easton's gaugings, that "there is therefore running to waste along three or four miles of the neighbouring coast, more water in a day than would suffice for the whole of Dover for a week."(1) Certainly the lowest gaugings give more than a day's supply for that place.

Mr. Topley notes that "the springs occasionally break out at about high-water mark; but more commonly they occur between tide marks, sometimes as fairly definite springs at one place, but more often at a multitude of places. They are thus generally difficult to gauge."(2)

Boatmen say that there are other springs at a lower level, only to be seen at very low water in St. Margaret's Bay.

Springs from the top part of the Upper Chalk.

Some of these will be more conveniently noticed under Intermittent Streams, as they fall naturally under that heading.

I can call to mind but one well-marked spring in the Isle of Thanet. This is little above Ordnance Datum at Brooks End, in the bottom of the valley S.W. of Birchington, and is marked on the six-inch Ordnance Map (25, S.W.). There is a smaller spring at Lower Hale, three quarters of a mile westward and N.E. of St. Nicholas-at-Wade.

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[1] *S. E. Naturalist*, 1894, vol. i, pt. iv. p. 109.

[2] *R. Comm. Metrop. Water Supply, Appendices*, p. 415.

The brooks (respectively flowing eastward and northward) from Mongeham and from Eastry, which meet nearly midway, result from a set of small springs. Those seen early in November, 1892, were practically stagnant, the heavy rains not having then affected them. At Northbourne, however, it was expected that there would soon be a flow, the bourne being said to be "within a foot of rising." The combined stream flows northward through the marshes between Deal and Sandwich, into the tidal Stour.

I re-visited this district in January and in April, 1907, and made the following notes. At Northbourne Court many springs were seen in the stream from about a third of a mile to half a mile below the Abbey Farm, and a spring issues north of the stream a little lower down, being marked (but not lettered) on the six-inch Ordnance Map.

Mr. G. C. Solly, the Expenditor of the Commissioners of Sewers (who, however, have nothing to do with sewage, but only with water-drainage, sewer being used with the old meaning of drain) accompanied me on one occasion, and told me that at Finglesham there is a small spring and water-cress bed, and that at West Street there are small springs.

At Eastry there is a small spring under the bank about half a mile north-eastward of the church, and along the short piece of stream that runs south-eastward from this, across the marsh, there are several springs. Others occur in the stream a little lower, about two-thirds of a mile from the church and below.

The fine set of springs at Wingham were noticed by me in the Memoir on the London Basin, as follows:—"At Wetherden Hall, half a mile south-west of Wingham, . . a stream rises somewhat suddenly. In its bed are many conical hollows, each . . the seat of a spring. Mr. Dowker who pointed this out told me that it was the chief source of the stream that flows through Wingham, . . yielding more water than the long branch from Ash."(1)

There are two fine sets of springs here. At Witherdens Hall the highest spring had been enclosed for the Wingham Waterworks (1892); but these have since been disestablished. Hence along the stream to Dambridge there are many other conical springs, several of considerable depth. At Dambridge, a rough measurement made the amount of water flowing down the stream to be about 2,400 gallons a minute. This has since been found to be understated, gaugings by Mr. Easton having shown this stream (a little to the north, where it may have been reinforced) to flow at the rate of 6½ million gallons a day, while the stream from the springs eastward of Winghamwell flowed at the rate of 7 millions. Later gaugings have, however, shown a much smaller flow, and in 1899 Mr. B. Latham made the following remarks: (2) "During the last year the springs in the chalk area have been lower than they have been known to be since the year 1874, at which time there was also

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[1] *Geological Survey Memoirs*, vol. iv., 1872, p. 392.

[2] In a Report to the Corporation of Margate, date May 20th,

a low water period. It unfortunately happens that these springs at Wingham were not gauged at the low water period, but I had them gauged at the beginning of April of the present year, when it was shewn that the springs at Witherdens Hall and below Dambridge Farm only yielded . . at the rate of 306,180 gallons in twenty-four hours . . The springs also at the South West of the Church from a gauging at Wingham Bridge gave 830,250 gallons in twenty-four hours, while at Port Rill the springs only yielded . . 7,470. . The total . . gives 1,143,000 gallons per day."

By Winghamwell, S.S.W. of the church, some of the springs have been used for watercress-beds. The flow down the resultant stream seemed to be greater than at Dambridge. At a visit made in January, 1907, all these springs were flowing strongly.

The Head of Port Rill, W.S.W. of the church, is a very small spring.

All three streams, supplemented by that east of Wingham, join just below the village, and soon flow into the Little Stour below Wickham Breaux. The other springs of the Little Stour system are referred to on pp. 58, 59.

Along the Valley of the Stour there are springs, and one is marked on the Ordnance Map (Kent, 46 S.E.), almost a mile N. of W. from Chartham church, at the right bank of the river. This is the one alluded to by SIR J. PRESTWICH, as probably connected with the swallow-holes on the higher ground (see p. 49).

MR. G. DOWKER has noted another at Canterbury, near White Hall, which "goes by the name of the Silver Hole. It was proposed by Mr. Pilbrow, the engineer, to utilize this spring for the water-supply of Canterbury." He continues: "Again, at West Bere, on either side of the river, like springs are met with."(1)

Of these last, however, we have an earlier account, by MR. J. BRENT, which is as follows:—"About two miles from Canterbury, in the marshes of West Bere Level, are a number of pools called Nicker Pits. Some of them are very deep, and springs of clear water rise up to the surface, the water finding its way into the marsh ditches, and thus escaping into the river Stour, near the banks of which the pools are situated. Many of them are funnel-shaped in the middle, and when standing on the margin, anyone looking into the water can see a long way down. The people in the neighbourhood believe them to be of an awful depth. One man told me that an eel-pot had been lowered into one of the pits seventeen rods, but it did not reach the bottom."(2) He discussed the meaning of the word "Nicker" and alludes to the superstitious feeling of the people living near.

CAPT. MCDAKIN adds that "the Nicker Pits below Westbere are in peat and alluvium covering the Thanet sands." These,

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[1] *Geol. Mag.*, dec. iii., vol. iv., 1887, p. 204.
[2] *Geologist*, vol. iii., 1860, p. 276.

"which are not more than 200 yards from the South Eastern Railway, are irregularly shaped openings usually filled with water on a level with the spongy surface of the marsh, which undulates as it is walked across."([1])

There is a well-marked spring, marked on the six-inch Ordnance Map (34), about two-thirds of a mile eastward of Faversham Church, which would seem to rise through a slight thickness of Thanet Beds. Perhaps the small fault, seen in the railway-cutting about two-thirds of a mile southward, extends on to here, and may have some connection with the outflow.

Another spring is a sixth of a mile S.E. of the church and another just eastward of the church.

There are springs up the valley south of Ospringe, one just east of the churchyard and another close by, near the Old Vicarage; these ought to be holy wells. Two others occur in the stream above the Vicarage. The spring-head is S.E. of Painters Forstal. (See also p. 60.)

Springs occur too on the branch of this stream just northward of Ospringe, eastward and south-eastward of the Workhouse.

By the farm called Wildmarsh, more than half a mile W.S.W. of Luddenham church, is a set of well-marked springs, at the marsh-level, apparently from the Chalk.

At Hog Brook, nearly two-thirds of a mile S.E. of Teynham Church, springs occur along the stream, which very soon enters the broad marsh. Some of these are funnel-shaped.

Just north of the railway, less than half a mile S.S.W. of the church, is a spring, the water of which, however, was fouled at our visit early in November, 1902, by the rain flowing down the road from the south.

At Tonge, just south of the railway, less than half a mile south-eastward of the church, a brook rises, and is reinforced in its northerly course by springs along the watercress-bed north of the railway, with some small ones from Bax. Although these are within the boundary of the Thanet Beds one cannot help thinking that their water comes up from the Chalk.

At Bapchild, St. Thomas-a-Becket's Spring rises in a rather deep hollow N. of the high road, less than a quarter of a mile N.E. of the church, and there are springs along the watercourse below. It is not easy to state the origin of this set of springs; the geological map makes them in the midst of the Thanet Beds, but one would not expect powerful springs from the sand thereof; on the other hand, from the lowness of level, it is likely that the Chalk comes very near to the surface here, and one would infer that here again water from the Chalk may rise up through the Thanet Beds.

At Sittingbourne, the names Waterlane Head and Chalkwell, on the high road at the western part of the town, mark the rise of water from the Chalk.

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[1] 22nd Report E. Kent Nat. Hist. Soc., 1880, p. 44.

Near Newington, is an interesting set of springs giving rise to a stream that flows northward to the marshes at Lower Halstow. The head-water of this stream comes from Tertiary sands in the wood south-eastward of the church (the water being thrown out by underlying clayey beds at a fairly high level). The chief springs, however, are in lower ground, a good way below the 50 ft. contour N.N.W. of the church, and the stream then forms a long mass of watercress-beds. These springs have been described as coming from Tertiary sands, but the volume of water in the stream seems to point to some other origin, the area of Tertiary beds available being certainly not more than two square miles, and perhaps a good deal less. Allowing a rainfall of 30 ins. (which is in excess of the truth), that every drop of it percolated through the Tertiary sands over an area of nearly two miles, and that all comes out at the springs, we should have a flow of about 2,000,000 gallons a day, or 1,400 gallons a minute; but the actual flow seems sometimes to be a good deal more than this.

One is led to think, therefore, that these springs may in great part be owing to water in the Chalk being forced up by pressure from behind through the lower sandy part of the Thanet Beds, the outcrop of the Chalk to the south being at too high a level to allow of outflow there.

We felt forced, therefore, to reject Prof. Hughes' ingenious explanation of these springs (Geological Survey Memoirs, Vol. iv., p. 392), as inadequate to account for the outflow. His work in that neighbourhood was done nearly 45 years ago, since which time the watercress-beds have been made, with, possibly, improvements in the springs.

In the paper by Mr. W. Bland, (referred to on p. 5), the Newington Pot-boiling, as it is called, is referred to as a Chalk-spring.

A good deal of water undoubtedly comes out of Tertiary sands hereabouts, adding materially to the flow of the stream.

Northward of Rainham, there seems to be a somewhat like occurrence to that at Newington, though probably on a smaller scale.

In the strip of marsh between Rainham Creek and Otterham Creek which connects Motley Hill with the mainland, although the ground (protected by banks on either side) is below the level of high water, the streams are of fresh water origin, resulting from water that flows out of the ground, with perhaps some inward leakage at high tide.

Here again the area of Tertiary sand available as a gathering ground is small, and it is therefore likely that there is some rising of water from the Chalk through the lower part of the Thanet Beds.

The banks of the Medway, in its passage through the Chalk, are mostly lined with alluvial mud; but Mr. W. Banks (City Engineer, Rochester), tells me that he has seen water flowing out freely along the foreshore between Rochester Castle and the bridge at low tide.

In the Hundred of Hoo, the springs seen were very small, but much water must come out from the Chalk along the edge of the marshes on the north.

There seems to be a spring close to the gateway of Cooling Castle, and there was water in the little chalk-pit just north of the Castle (21st November, 1892).

At Messrs. Francis' large pit, westward of the village of Cliffe, the chalk was dug down to water. Water got from the chalk near the marsh-edge here was brackish, but that further in the pit fresh.

There seems no sign that a very large amount of fresh water could be got here. Perhaps the flow through the Chalk from the south is hindered by the trough of Tertiary beds in that direction, the effect of which would probably be to close the fissures in the upper part of the Chalk. Again, as the uprise of the Chalk seems to extend westward across the Thames into Essex, that might tend to facilitate the entrance of salt water into the Chalk, the fissures of which would be fairly open along the slight arch.

The water from the tunnel between Strood and Higham (made for a canal, but taken for the railway), has been alluded to by MR. P. W. BARLOW as derived from powerful springs, yielding 300 gallons a minute and cut above high-water-mark.(1) A Report by PROF. ANSTED, quoted by Mr. Barlow, makes the yield more, for he says:—"At the entrance of the tunnel . . . a strong spring comes out of the chalk, at some distance above high-water mark, and delivers as much as half a million gallons of water per day."(2)

Some of the water from the tunnel seems to flow out very quietly at this northern end. At our visit no appreciable flow was to be seen. Of course, these springs are really artificial.

It is recorded that at Gravesend, in making excavations for the piers, springs were found.(3) Along the Chalk-foreshore, in front of Clifton Marine Parade, a set of small springs can still be seen at low tide; but their water is more or less brackish. These are probably what PROF. ANSTED refers to in saying:—"Beyond Northfleet, where the chalk is seen on the river bank, the water everywhere oozes out from the exposed surface, and trickles down in a multitude of very small streams."(4)

At Northfleet, the shore is much hidden, but PROF. ANSTED has noted that "near the (abandoned) dockyard . . . an extremely powerful spring pours out, near the low-water mark of spring tides, along a line at least twenty feet in length . . . it would probably be safe to estimate it as equivalent to a million of gallons per day."(5)

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[1] *Proc. Inst. Civ. Eng.*, 1855, vol. xiv., p. 54.
[2] *Ibid.*, p. 57.
[3] *Ibid.*, p. 55.
[4] *Ibid.*, p. 58.
[5] *Ibid.*, pp. 57, 58.

We were assured by boatmen that water also comes out at low tides further westward, and there is said to be a spring in the creek which is the outlet of the Ebbsfleet stream.

The stream in question rises at two places, the shorter arm at Rectory Place, nearly half a mile south of the church; the chief arm at Springhead, where the highest outbreak is very gentle; but lower down there are many springs in the stream, the inverted cones of which are marked by clear spaces in the long watercress-bed. This stream has been roughly estimated as yielding about 7,000,000 gallons a day.(1) Prof. Ansted adds that "the greater part is again absorbed by the porous strata before reaching the river." Funnel-shaped springs are shown at many clear spaces in the watercress-bed a little northward of Springhead.

On July 11th, 1898, there was plenty of water at Springhead, although extensive pumping from the Chalk had been going on from various wells at Northfleet, which clearly, however, had not been enough to drain the area behind the spring. At a later date, however, the whole stream became dry, through still more extensive pumping (see Addenda).

There are probably many springs along the bottom of the Darent Valley, in the river on the side-channels. Apparently there is one in the marsh a little eastward of Hawley Mill, and nearly on the eastern bank at the angle of the side-stream, about two-thirds of a mile N.N.W of Darenth Church is a small set which probably flows only occasionally.

The springs of the Cray Valley are mostly noticed further on (p. 61), but I am not sure whether the two we noticed in November, 1892, are included in these. The higher of them is on the northern side of the road that forms the parish boundary of St. Mary Cray, opposite Rheidol Cottages, and the water bubbled up. The other is on the western side of the road just north of Springhall, a third of a mile south of St. Mary Cray Church.

Prof. Ansted says that at Erith, "when the water is very low, a group of exceedingly strong springs may be seen issuing out from the thick mud on each side of the pier and within a range of a few hundred yards," and Mr Barlow remarks that he measured one set, "and found 500 gallons per minute flowing from it," and he has "no hesitation in stating that a quantity of water, exceeding 1,500,000 gallons per day, escapes in a length of 250 yards of the river bank."(2)

At our visit in 1892, we were told that of old, chalk was seen along the foreshore from Lower Ballast Wharf to the Pier, but there is now only mud at the surface, through which springs come up. Opposite Messrs. Cannon and Gaze's Mill, or about 400 yards above the Pier, there is a broad round hollow in the mud, which is formed by one of these springs.

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[1] Barlow and Ansted, *Proc. Inst. C.E.*, 1855, vol. xiv., pp. 54, 56.

[2] *Ibid.*, pp. 57, 54

The level of the water in the well at the mill is about 18 ft. down, and is not affected by the tide, the water being pumped from about 150 ft. down. The level of the water in shallow wells at the Maxim Works, in the large ballast-pit, is affected by the tide, at an interval of about an hour.

The following notes of springs higher up the Thames are from the paper above quoted.(1)

"At Woolwich several similar springs occur; one of which is used by the shipping there for fresh water, which is obtained by excavating a hole in the beach, when the tide is out." Springs too were found in excavations for "the dry-docks at Woolwich."

"In the Charlton Marshes springs also occur, yielding above 200 gallons per minute."

"At Greenwich Marsh, close to the coping of the tram road and the high-road (east of the town), a spring comes out of the chalk, quite at the top of the rock, running about 250 gallons per minute. A few hundred yards beyond, towards Charlton, another small stream is seen by the road side of less power."

Springs from the Lower Chalk, along the Escarpment.

We come now to an interesting group of springs from the bottom part of the Chalk, and sometimes from the very base, some of which have been directly taken for public supply. They are mostly well-marked and often of considerable flow. The first we have to notice are less than 1½ miles from the sea.

Northward of the town of Folkestone is St. Thomas' Well, a spring marked on the Ordnance Map (Kent, Sheet 75), in the bottom of the combe on the northern side of Sugarloaf Hill, with a tributary-spring a little north-westward.

Next come the similarly placed springs in the combe westward of Castle Hill, which are taken for the supply of Folkestone (see p. 64).

At Newington, I believe that one of the springs northward of the village has been used for supply.

The varying springs at the head of the Little Stour, from Etchinghill downward, are noticed further on (pp. 58, 59).

At Postling, there is a set of powerful springs (one of the head-waters of the Stour) at the foot of the bank at the southern side of the road a little northward of the church, from which much water flowed when I was there in December, 1898, and on a later occasion.

There are springs at Monks Horton, and northward at Stowting, are the heads of a stream that is a tributary of the Stour. Others occur westward at Brabourne and Brooke (Cocklescoombe).

Crossing the Valley of the Stour, we come to the springs at Eastwell, in the Park and at Shoddington.

At Westwell, a set of springs a little north of the church was flowing when I was there, in November, 1898. These

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[1] *Proc. Inst. Civ. Eng.*, 1855, vol. xiv., pp. 54, 56.

are the head-waters of another tributary of the Stour, and are reinforced by another spring a little lower down, by Penton Court.

Another tributary of the Stour starts at Charing. The western head-waters of the Stour itself rise at Lenham.

Passing now from the drainage-system of the Stour to that of the Medway, we have at Harrietsham some of the head-waters of the Len, westward of the church, at Hamilton springs, more than half a mile north-westward of the church, and at Synden Pond, nearly a mile north-westward of the church, where there are many springs. In a Report to the Corporation of Maidstone, Mr. W. Fox, from observation (February 14th, 1898), estimated the yield of the Hamilton Spring at from 100,000 to 130,000 gallons a day.

There are other springs westward along the foot of the escarpment at Hollingbourne and Thornham, and at Boxley are some of those, and for the supply of Maidstone (see p. 67). There is one on the western side of a small wood less than two thirds of a mile W.N.W. from the church, another close by (over two thirds of a mile from the church) and a set at Boarley.

In the Parish of Aylesford are two other sets of springs taken for Maidstone, the first about a quarter of a mile northward of Cossington, where there are two deep gullies, with sharply sloping sides, ending upward suddenly, and each with a large flow of water; the second (very small), near by at Spring Farm. Besides these are others at Tottington, about a mile north-eastward of the church, some of which are, I believe, used for an estate-supply. Here, there are many blocks of greywether-sandstone around the spring.

From the Medway to the Darent I am less familiar with the springs, not having seen them for many years, nor do I know of any detailed account of them.

At Birling, springs are marked on the Ordnance Map (Kent, Sheet 30), at The Place and at Coney Lodge.

Eastward of Wrotham are three springs, all within a mile of the church and marked on the Ordnance Map (Kent, Sheet 30). Of these Mr. F. J. Bennett says that the one north of Moat Farm is very strong and that another, near the Spring Tavern, has never been known to be dry, and he notes another by Newhouse Farm, westward of the village.(1)

Just before we reach the Darent, Upper Greensand sets in between the Chalk and the Gault, and there may be communication between the first two, in places at all events. A spring three-quarters of a mile west of Kemsing Church (near Dipper's Hall), probably rises from the Chalk.

Crossing the Darent at Otford, springs marked on the Map (Kent, Sheet 29), a little southward of Twitton form the head water of the Twitton Brook, which flows north-eastward to the Darent.

At Brasted, there is a strong set of springs from the base

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[1] Ightham: The Story of a Kentish Village, 1907, pp. 2, 3.

of the Chalk at the head of a pond, S.S.W. of Court Lodge, and I have a record of a gauging of the total flow, made near the middle of the pond, of 1,148,000 gallons a day. As a record from the outflow of the pond was only 939,000, it looks as if there were some absorption between the two spots, ? into Upper Greensand.

Between a third and half a mile westward, in the parish of Westerham, is another spring-head apparently also at the base of the Chalk.

THE SELBORNIAN.

The *Upper Greensand* is confined to the western part of the county, and there is of little importance, having but a very narrow outcrop.

A spring about half a mile W.S.W. of Kemsing Church probably rises from this formation. MR. J. LUCAS(1) mentions also St. Edith's Well and the spring west of Dippers Hall, as from the Upper Greensand; but, judging by the Geological Survey Map (which, of course, may be wrong), I am in doubt whether these two are not from the Chalk (see above), and MR. F. J. BENNETT has treated the former as such, saying that it is in the village, and is a very powerful spring, dry the first time for many years in 1901-3.(2)

MR. LUCAS also notes the following springs at Otford:— St. Thomas à Becket's Well and Moat Farm Springs, which again I think may be from Chalk, and, on the western side of the Darent, at Broughton House, Newbarns and Rye House.

The spring just E.N.E. of Court Lodge, Brasted, is apparently from Upper Greensand, and there may be others between Otford and here, the water of all being thrown out by the underlying Gault clay.

The *Gault* being essentially a clay, we do not look to find springs from it, but in November, 1898, I found springy ground some way above the base of the Gault in Eastwell, between Lenacre Hall on the south-east and Eastwell Court on the north-west. In two places the word Spring occurs on the Ordnance Map (Kent, Sheet 65), and a stream is marked. The more south-easterly of these was dry at the time of my visit, except at the southern end. At the other, near Eastwell Court, I was suspicious of water being led to the spot by a pipe. Anyhow, the occurrence of springy ground at such a place is remarkable. There may be sandy beds in the Gault, or perhaps water from the underlying sand of the Folkestone Beds may rise up through a fissure, which, however, on the face of it, does not seem likely. In Lincolnshire, powerful springs seem sometimes to come up from the Jurassic limestones, through a certain thickness of Oxford Clay, the great spring at Bourn being a case in point.

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[1] *Trans. Inst. Surveyors*, vol. ix., p. 176.

[2] Ightham: The Story of a Kentish Village, 1907, p. 3.

LOWER GREENSAND.

In so permeable a formation, consisting chiefly of sand and always with a basal clay, springs must be common, but they have not generally that definite character so usual with springs from the Chalk or other thick limestone. **Mr. Topley** has remarked:—"Powerful springs occur in many places; but it is doubtful if these could well be utilised [for supply]. They are largely used by mills."(1)

Where the clayey Sandgate Beds occur the water is thrown out at favourable spots from the overlying Folkestone Beds, but where the former are absent, or so poorly represented as to be unmappable, water may pass through into the Hythe Beds, and then there will be but one set of springs, thrown out by the Atherfield Clay, instead of two sets.

But few details can now be given, and the formation will be treated as a whole. The following account indeed is very far from perfect, and the springs noticed are examples only.

The springs thrown out from the Folkestone Beds by the Sandgate Beds have been the cause of the landslips along the coast of Sandgate.

At and eastward of Hythe, there are springs from the base of the Hythe Beds or Kentish Rag, and these are used for supply (see pp. 64, 65).

Westward from Hythe for several miles, there are like springs which have given rise to the remarkable line of irregular landslip-slope, on part of which the Roman Castle of Lympne has been brought down. Many of these springs are marked on the Ordnance Map (Kent, Sheet 74).

Mr. G. Dowker notes springs further inland from this ridge at Cheriton, Newington, Saltwood, and Sandling Park and Lympne, but gives no details.(2) One at the last place is marked on the Ordnance Map (Kent, Sheet 74), just north of Coldharbour, about 1⅓ miles W.N.W. of the village, and the water must be thrown out from the Hythe Beds by the Atherfield Clay.

I am indebted to **Dr. H. F. Parsons** for the following account of some springs in the parish of Broughton Malherbe.

They occur at Liverton Street (Leperton of old map), half a mile W.N.W. of the church, and rise from the base of the Hythe Beds at the junction with the Atherfield Clay. There are four springs, near together, the aggregate yield of which on April 28th, 1898, was 18½ gallons a minute, and on October 7th (a dry season), 12½ gallons.

In 1898 the Rural District Council proposed to use these springs for the supply of Headcorn, four miles off, and applied to the Local Government Board for sanction to a loan; but, in the meantime, the South Kent Water Co., in whose area Headcorn is, but whose powers had lapsed, suddenly stepped in and laid mains to Headcorn so the scheme was not proceeded with.

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[1] Rep. R. Comm. Metrop. Water Supply, 1893. Appendices, p. 417.

[2] *Geol. Mag.*, 1887, dec. iii., vol. iv., p. 205.

Mr. F. J. Bennett has written to me of a set of springs at the foot of Chart Hill (? western side), in the parish of Chart Sutton, where he saw three strong springs and found much tufa over the surface, and he says that a set of spring-ponds occurs on the plateau of the Hythe Beds along the water-parting between the Len and the Loose.

Mr. Topley has remarked that:—"There are but few springs along the Lower Greensand escarpment west of Chart Sutton up to the Medway; but on the east of that place the beds near the escarpment roll slightly over to the south, and here there are springs feeding brooks which flow into the Beult. These springs at the escarpment are not of much avail in draining so large an area of Greensand. But those along the Medway and in the valleys of Loose and the Len are certainly of very great importance; and the quantity of water carried by them into the Medway must be very large." And, speaking of the Maidstone district, he says:—"There are some strong springs about Mereworth, and all down the Medway from Wateringbury to Maidstone. On the north there are some very strong springs about Bradbourn and St. Leonard's." On the east of the Medway too, "there are . . . springs all along the river bank."(1) The springs formerly used for the supply of Maidstone are noticed further on (p. 65).

Mr. F. J. Bennett has given me the following notes of springs at and near West Malling. Gillet's Hole is the name given to the spring at the southern part of East Malling, a quarter of a mile from the church. A good deal of water rises there and supplies many of the houses, having once been the sole supply, fixing the site of the village. The resultant stream flows through the village, turning eastward near the church and soon sinks in a small swallow-hole.

S.W. of Springates Hill and about a mile from the church, a stream starts at a spring-pond, but soon sinks to reappear at Well Street, over half a mile from the church.

At Leybourne, more than half a mile N.N.W. of the church, a spring (marked as Well on the Ordnance Map) rises west of the road, and east of the road the water divides into two streams, close together. The northern is highly ferruginous, the other quite clear. They soon join and the peculiarity ceases.

At West Malling, just east of St. Leonard's Tower, is a dip-hole at the head of the spring. At uncertain times, and less frequently of late, this spring rises rather suddenly and has flooded the road and the houses close by. This occurred on March 5th, 1904, the first time for many years, when the water rose above the dip-hole in the garden close to the Tower. In 1874, the water rose so much that the people in the houses at the park entrance were flooded out of the lower rooms and had to live upstairs for six weeks. At other times the cascade in Swan Street has run dry, as in 1903.

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[1] The Geology of the Weald, 1875, pp. 362, 363.

At Offham, there are spring-ponds from Godwell to just west of the church.

Of the little valley from two to four miles southward of Wrotham Church, Mr. Bennett says:—"At Bastead, the Atherfield Clay below the Hythe Beds throws out powerful springs all down the valleys, as Plastol Spout, *etc.*"(¹)

From the same work (p. 49) we learn that at Redwell, a mile south of Ightham Church, springs issue at the base of the barrow, that there are two swallow-holes close to the barrow, and (p. 57) that the whole parish abounds with springs, several place-names of a water-origin being cited in evidence.

Writing of springs, he says:—"There are also some rather remarkable ones very high up on the slope of the Folkestone Beds, as at Oldbury Camp, Styant's Bottom, and Water Den . . . all on one horizon, as if due to a bed of clay (Fuller's Earth perhaps) in these sands." Of the first of these he adds that: "In the middle of the [?northern edge of the] camp, there is a spring running northwards which supplied the occupants with water."(²)

In the Sevenoaks district there are also springs, but the only note I have is of those at Bradbourne, N.N.W. of the town, where there are several, some of which are marked on the Ordnance Map (Kent, Sheet 40). Besides these are some at the eastern end of the southernmost pond and another occurs to the S.W. close to the railway. The name Riverhead is of course suggestive.

THE HASTINGS BEDS.

Springs rise from the sandy members of this Series (the Tunbridge Wells Sand and the Ashdown Sand), but as a rule, the beds are of finer grain and less permeable than those of the Lower Greensand. Those of Tunbridge Wells are perhaps the only well known ones, and the water is medicinal and by no means fit for ordinary supply.

Mr. Topley has said: "The chalybeate springs at Tunbridge Wells are too well known to need description here. Probably more has been written on them than on any other medicinal wells in England, save those at Bath."

"There are other wells in the neighbourhood, which at one time were of some note. Adam's Well, at Speldhurst, was perhaps the most celebrated; but this had, even in 1766, so far degenerated as to be 'only famous for the cure of mangy dogs.' (Burr's Hist. of Tunbridge Wells)."(³)

According to Mr. J. Thomson, who treats of the Chalybeate spring at Tunbridge Wells, and whose analysis is given on p. 282. (⁴) "The spring is situated at the east end of the

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[1] Ightham: The Story of a Kentish Village, 1907, p. 3; also pp. 99, 128.
[2] *Ibid.*, pp. 3, 53.
[3] Geology of the Weald, 1875, pp. 352, 353.
[4] *Journ. Chem. Soc.*, 1858, vol. x., p. 223, 224.

Parade, and rises through an aperture the diameter of which is about $2\frac{3}{8}$ inches, into a marble basin . . over the side of this basin the water flows into a channel connected with an outer basin which is open to the public, depositing in its progress a reddish brown precipitate of sesquioxide of iron. The side of the present basin, which has been in use about nine years, is much corroded where the water overflows, from the action of the carbonic acid contained in the water."

"The temperature of the water as it issues from the spring is invariably 10° C. (50° F.)."

The flow of the spring, as noted by Sir C. Scudamore, from August 1815 to the beginning of March 1816, varied from a quart to $2\frac{1}{2}$ gallons a minute.

Mr. Thomson continues:—"The water as it issues from the spring, is beautifully clear and transparent, and small bubbles of gas intermixed with occasional larger ones are continually rising to the surface. In taste and smell it is decidedly chalybeate, but not at all disagreeably so. Its specific gravity . . is 1·00037."

Of the Coneyburrow Springs, just north-east of the town of Tunbridge Wells, Mr. T. Hennell has given me the following guagings, the first set made by himself, in gallons a minute.

1. On main stream, W.S.W. of Liptrap's Farm 2. On side-stream S.W. of the farm. 3. By spring W.S.W of the farm.

Date	Weir 1	Weir 2	Weir 3	Total	or in 24 hours
15 June, 1883	31·75	15·82	10·8	58·37	84,050
29 ,, ,,	31·75	15·	10·8	57·55	82,870
13 July, ,,	33·75	17·	11·74	62·49	89,985
2 Aug., ,,	25·7	10·8	10·8	47·3	68,112
22 ,, ,,	31·75	9·31	9·31	50·37	72,532
22 Sept., ,,	30·	6·75	7·5	44·25	63,720
20 Nov., 1884	18·6	15·	0	33·6	48,340

Gaugings at Weir 1 only by Mr. Quick gave 77,000 gallons in 24 hours in September, 1882, and 91,000 in January, 1883; others, by Mr. F. Cooper gave 132,480 on Feb. 3, 1883 "during heavy rain," and on Feb. 4, 115,200 "after 20 hours cessation."

Springs taken for supply, here and at Penshurst, are noticed on pp. 67, 68, and in 1895 I was told at Cranbrook that a spring, marked on the Ordnance Map (Kent, Sheet 70) about an eighth of a mile south of the church, was used by many people. Two others springs are marked higher up the valley, toward and at Brickkiln Farm. All three are thrown out from the Tunbridge Wells Sand by the underlying Wadhurst Clay.

SWALLOW-HOLES.

Whilst for the most part water gets into the Chalk by percolation through the soil, there is another method by which local additions of water are more rapidly made, and this is sometimes of importance in regard to the possibility of pollution occurring, as it obviously may, if water that has flowed over the surface of the ground and perhaps acquired undesirable matter in so doing, gets into the Chalk in a somewhat direct way.

This sinking of water into the Chalk has been described in various Geological Survey Memoirs, and the notes on the subject, as far as the Thames Basin is concerned, were collected together as a Memorandum for the Royal Commission on Metropolitan Water Supply (1893, Appendices, pp. 430-433). It will be useful to reproduce this as far as regards Kent, with some slight alteration in form, and then to add notes on other swallow-holes.

Swallow-holes, that is, more or less funnel-shaped hollows which swallow up streams that run in to them, are common. They are formed by streams which, rising in the higher ground, flow down the escarpment of the Tertiary beds, until they reach the more pervious and jointed Chalk, into which they sink, or until they come within a short distance of that rock, when they work their way into it through the few feet of the softer overlying beds. In the course of time, through the chemical action of the carbonic acid in the water, and the mechanical action of the water itself, funnel-shaped basins are worn in the Chalk and the beds above, the operation being made more easy by any pre-existing fissures. These hollows are often thickly overgrown with vegetation. The streams may sometimes be seen running down them, though sometimes they merely flow into a small pool, the level of the water in which remains the same, notwithstanding the constant inflow.

Mr. F. J. Bennett has come to the conclusion that "all swallow-holes, in their *first stages*, began from below." He adds: "swallow-holes [presumably those in valleys] seem to me to have passed through a series of stages; being initiated by an upward pressure of water, and that where they now absorb water they are in a later stage."(1) For present purposes, however, we have only to do with the downward stage.

On the northern side of the London Basin these swallow-holes mostly occur at or near the junction of the Reading Beds and the Chalk. They sometimes occur, however, at a distance from the Tertiary beds, and sometimes well within their boundary (where the lower beds are sandy).

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[1] "Ightham: The Story of a Kentish Village," 1907, pp. 129-131; see also p. 128.

They occur also where the Thanet Beds are present (between the Reading Beds and the Chalk), especially where these are comparatively impervious, as in East Kent.

In what is probably the earliest systematic description of swallow-holes (and in Kent) SIR J. PRESTWICH has well summarised the essentials for their formation, on hill-slopes: those in the bottoms of stream-valleys are another matter. His words are as follows: "It would appear that two conditions are essential for the formation of swallow-holes: the one, that there should be streams formed at such a level that they have to pass over a surface of country higher than that of the main valleys of drainage; and the other, that the line [plane] of water level in the mass of calcareous strata in which the swallow-holes are formed should be below the level at which the streams drilling the swallow-holes are absorbed."

MR. G. DOWKER has noted that at Woodnesborough "there are large 'swallow-holes' which absorb the water from the surface and convey it some distance underground."(1)

It is from the above-quoted paper by SIR J. PRESTWICH(2) that the following details of swallow-holes are taken: they were not given in the Report above mentioned. It deals with the neighbourhood of Ensinge, a few miles westward of Canterbury, and the tract referred to is at the southern end of the Tertiary hills in part marked as Fishpond Wood on the old Ordnance Map (Sheet 3) and "extending over the London clay and Lower Tertiary sands down to the edge of the chalk. The drainage from this clay surface is carried off by several small brooks (not marked on that map) having an easternly or a southerly direction . . Skirting the wood from Nick-hill (Nackholt) Farm westward to Lower Elmsden (Ensinge) there are to be found within a distance of about a mile as many as six or seven of these water-courses, all of which . . disappear just within the edge of the wood, in swallow holes, some of which are not more than 6 or 8 feet broad and deep, whilst others attain a diameter of 30 to 40 feet and a depth of 20 to 30. There is generally not much water in the brooks running into these funnel-shaped excavations, at the bottom of which they form a small pool, that, notwithstanding this incessant addition, remains unchanged and without rise, the water being gradually and quietly absorbed as fast as it is supplied. Only occasionally after heavy rains the water stands for a few hours some feet higher. The sides of the excavations are usually sloped with debris, grass, and bramble, and the bottom covered by a bed of sand and gravel so that the chalk surface cannot often be seen. Some of the swallow holes are situated within the boundary of the Lower Tertiary sands, whilst others are just on the edge of the chalk. Between this spot and the river Stour at Shalmford Street there is a descent probably of 200 to 300 feet [less than 200], throughout which the surface of the chalk is as bare of wood as it is of water. But on the river-bank near that village a large and perennial spring bursts out. There are, I believe, several other springs in the river, but this is a very striking one, and is apparently dependent upon the brooks lost in the swallow holes a mile distant on the hills above. Not that I think that the streams are continued underground in separate and independent channels from the spot where they disappear to that at which they issue in the river-bank, but that they descend, within a short distance, through one or more channels down through the mass of the chalk, until they reach the line [plane] of permanent water-level which passes under the hills in a curve rising slightly from the river Stour and descending again towards Faversham. The additional supply made by the brooks at this spot determines a higher local level in the water-line, and consequently the springs issue in greater force, and higher above the river, along the nearest lowest level of the valley. . . The bulk of the springs are probably in the bed of the river, or low on its banks, and are therefore not so apparent."

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(1) *Geol. Mag.*, dec. iii., vol. iv., 1887, p. 204.

(2) *Quart. Journ. Geol. Soc.*, 1854, vol. x., pp. 222-224.

Eastward and north-eastward of the above set of holes "from Hatch Green (Chartham Hatch of the newer map) to Dinstead (Denstead Farm) and Fishpond Farm (not named on the newer map, but close to White Wall) there are several other swallow-holes." I saw one in Howfield Wood, of the old map, included in Bigberry Wood in the newer one, more than half a mile east of Chartham Hatch.

Writing of Bigberry Wood, CAPT. MC.DAKIN remarks that there are some deep holes in the western corner, "with subterranean streams that may be heard running at the bottom. . . They are from twenty-five to twenty-nine feet deep and they pass through the Thanet-sands for about 25 feet to the chalk."

He holds that the holes have been formed by the subterranean stream, apparently anticipating MR. BENNETT's view. (p. 45.)(1)

There are swallow-holes at the western foot of the same range of hills, southward of Boughton Street, in the re-entering angles of the boundary of the Thanet Beds at Oversland, and South Street, close to the junction with the Chalk; these receive the water from the high ground eastward. Under ordinary circumstances, the water would break out again from the Chalk lower down the valley; but early in November 1892 heavy rains caused this drainage to overflow in great part, making a mostly continuous watercourse, the water of which betrayed its origin (drainage from the Tertiary beds) by its turbidity. In two places, however, artificial swallow-holes caused local sinking of the water. One of these places was by the roadside just S.E. of South Street, and the other by the roadside just N.W. of the hamlet, where the water was pouring down a hole kept open by a pipe.

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[1] 22, *Rep. E. Kent N H. Soc.*, 1880.

There are also some swallow-holes round the border of the Selling outlier.

It should be noted that these eastern swallow-holes are near the boundary of the Thanet Beds, which there come in between the Reading Beds and the Chalk; but in East Kent this formation does not consist merely of sand, as in West Kent, being largely composed of clayey beds; so that for the most part it does not allow water to percolate through to the Chalk.

No swallow-holes in the Chalk have been noted for many miles westward, the next being at the Swanscombe Tertiary Outlier, where there is a swallow-hole just within the boundary of the Woolwich Beds, at the re-entering angle in the wood north-eastward of Green Street Green. The water must find its way through the Thanet Sand into the Chalk, as there is no stream.

On the Well Hill Tertiary Outlier, south-east of Orpington, at the eastern edge of Hallow (Hollards) Wood, just south of the road to Cockerice (Cockerhurst), there is a swallow-hole, and there is another to the south. Both are at re-entering angles of the boundary-line of the Thanet Sand.

Turning to the spur of the Tertiary Beds, eastward of Foot's Cray, the water that at times runs down the channels on the eastern flank of the hill of Jerden's Wood sinks at the bottom of the slope in swallow-holes.

Mr. J. Lucas has noted a powerful swallow-hole south of Birchwood Corner at the re-entering angle of the boundary over half a mile north-east of Swanley Station; but he says that the stream supplying it may be dry at times.

In Cookham Wood, a triangular patch just over a mile westward, I saw two swallow-holes, many years ago. Since then it seems that the stream supplying them has been artificialised; at all events it is not now (? 1892) flowing in a natural channel. At a later visit the lower swallow or set of swallows, was in full action, the stream disappearing in, and at the edge of, the wood; but the higher swallow-hole seemed to have been abolished by the cutting of a channel.

At St. Mary Cray a swallow-hole has been noted in the valley a little south-east of the Railway Station, where the junction of the Thanet Sand and the Chalk is hidden by gravel.

Worley Hole, about half a mile north-eastward of Farnborough church, and on the western side of the road to Orpington, is marked on the old Ordnance Map (Sheet 6), and is a little below the boundary of the Tertiary beds, on bare Chalk.

The following notes on the Chiselhurst Chalk Inlier were taken many years ago, before the place was so much built over. They refer to the southern end of the inlier, eastward of the Railway Station and south of the road to Bromley.

In the wood, between the lime-kiln and the large old pit a long triangular steep sided chasm has been cut in the sand. At the pointed eastern end, about 10 feet deep, a stream fell into it and then flowed with a sharp slope to the western end (the base of the triangle, and about 40 feet deep), where the sides were very steep and where the water ran into a hole in the Chalk, which rock is just shown at that end. I do not know whether this swallow-hole is natural or not, but I expect not, for the wood is full of holes, some of which are old pits, and others may have been caused by the falling in of the ground from under-mining, though some may perhaps be true swallow-holes.

The above notes refer only to the border of the Tertiary beds and the Chalk; but swallow-holes have also been found in the Lower Greensand, and Mr. F. J. Bennett has noticed some of these.(1) The following account is taken from his book, largely supplemented from information that he has kindly given. I am answerable only for the arrangement, with some additions as to sites.

He divides the swallow-holes into two classes, active and extinct, which, however, occur together, and he says that on the Hythe Beds they occur (1) in the valley-bottoms, (2) just within a valley, and (3) on the water-partings.

It will be seen that some of the swallow-holes now to be described, being in valleys, are connected with intermittent streams and might therefore be described under that heading; but it seemed better to take all Mr. Bennett's records together, acknowledging the connection between the two sets of phenomena and the difficulty in separating them.

On the map opposite p. 128 of his book a number of swallow-holes are marked near the course of the River Loose, south-eastward of Maidstone, and just northward of that valley, and these are described as now dry, except No. 9, just above Langley church, which "takes in all the water draining to it." These swallow-holes "are either oblong and deep . . or deep and crater-shaped." Of them "Nos. 1—5 are parallel with the course of the R. Loose," from near Park Farm, to near Boughton Green. The rest (6—8, 10—15) are on slightly higher ground near Langley and Otham.

The tributary valley to the Len that runs north and south along the boundary between Otham and Maidstone (and of Senacre Wood) "contains many swallow-holes . . some in the upper part contain water and some are dry." He adds (1908) that there are 13 and all but one dry.

By the footpath from West Malling to Leybourne there are three circular depressions, two in the outlier of Folkestone Beds, the other on the Hythe Beds, just below. These Mr. Bennett thinks are due to extinct swallow-holes.

There is also a deep circular hole near the stream in Malling Wood, close to Leybourne, and another at Larkfield Heath, just north of the road two-thirds of a mile eastward of Leybourne, both of which may also be extinct swallow-holes. The former seems to be at the top of the Hythe Beds and the latter is in the Folkestone Beds.

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[1] Ightham: The Story of a Kentish Village and its Surroundings, 1907, pp. 2, 49, 128, 129, 131–134, and plate opp. p. 128.

In a letter of December, 1907, Mr. Bennett marks nine of these, beginning on the south, close to the high road, with a large and deep one, known as Bicknor Hole. The next, westward of the Bell Inn, is marked as a pond on the Ordnance Map (Kent, Sheet 42), and then there are three in the wood where Smugglers' Hole is marked on the map, the most northerly being large and the one to which the name applies; it is now always dry. There are two others a little further north; then another, in a projection of the wood; and lastly one, at the northern end of another projection of the wood, about two-thirds of a mile northward of the high road.

Near Offham is a line of swallow-holes, for a little more than a mile from E.S.E. to W.N.W., the sites of the whole six being marked in some way on the six-inch Ordnance Map (30). The most easterly is in a little but thick wood north of Fatherwell, and is at a slightly lower level than the ground to the west. It is of the active type, draining several acres and swallowing all the water that runs into it. Its activity is due to artificial causes, as the water is drained into it by a culvert, and it is used to drain the water from the ground to the S.W.

The next, also in a small thick wood, to the W.N.W., is a long but not deep hollow. It is of the extinct type, as also are the next two, in other small woods north-eastward and north-westward of the church. These are much deeper, with steep sides and irregular bottoms, in which are many holes.

The next two are marked as ponds, the first, W.N.W. of the church, being shallow, circular, and fed by a spring. The last, on the southern side of the high road a little east of Hernewell, is a large deep crater-shaped hole, having in it another smaller hole. In June, 1907, it had a little water, but once it had much more, and the water used to overflow from it, as well as from the other pond. Of late years the water-level has sunk much and no overflow has occurred for a long time.

It would seem, therefore, as if some of Mr. Bennett's swallow-holes are of the vacillating kind, sometimes spring, sometimes swallow, as happens elsewhere.

He regards Baldwin's Hole on the southern side of the main road, about half a mile eastward of Offham, where the road to West Malling branches off, as an old swallow-hole, breached on one side, which took the water that came down the valley from the west; storm water still sinks there.

He regards the remarkable valley ending in the pond at Swanton, about a mile westward of Mereworth church, as another breached swallow-hole. A spring issues a little above, and according to the six-inch Ordnance Map (41) is lost in the pond.

Near Ightham there are again swallow-holes, and in his book (p. 2) Mr. F. J. Bennett notes two of these, "one where a stream, rising close to the base of the Tumulus at Redwell, disappears shortly after, in a garden north of, and close to, the road, and near the 'Old House at Home.' The other . . is about half-a-mile south of the Tumulus near Dale Cottage. . . One of these occurs in the Folkestone Beds but close to the boundary between them and the Hythe Beds, and the other at the junction of the Sandgate [? Folkestone] and Hythe Beds." Of the first of these he adds that it is dry at times, but full of water when the springs are high, and of the second that it seems always to be full of water.

There is a third over a quarter of a mile N.N.E. of Joy Heath, which takes in a lot of water, but is sometimes dry.

Another, over a third of a mile N.N.E. of that place, now nearly filled up, was once deep, according to Mr. B. Harrison.

In the little wood about half a mile south-eastward of the village, is a large depression, which may have been a swallow-hole.

INTERMITTENT STREAMS.

Allied on the one hand to swallow-holes and on the other to springs, both of which sometimes occur along their courses, we now come to treat of the interesting occurrences of streams which either vary greatly in their starting-points (according to the wetness of the season), which sometimes show alternations of wet and dry beds along their courses, or which even are non-existent in dry seasons, occurring only after heavy rainfall.

These are fairly common in limestone-districts, and especially perhaps in the Chalk, which often has so wide an outcrop as to afford plenty of room for the formation of fairly long valleys. Known as Gypseys in Yorkshire, as Lavants in Sussex, as Winter-bournes in Wilts., and simply as Bournes round London, the usual Kentish name for them is Nailbournes.

Their origin was once, and not so very long ago, a great puzzle, and wonderful theories were evolved to account for it; notably that of syphons, which periodically emptied a huge underground reservoir. Now, however, they are well understood, and their origin is known to be of the simplest, depending as it does merely on the gradual rise of an underground water-plane, after a wet season, until at last that plane rises to the level of the ground in certain low-lying parts, the result being of course that the underground water finds an exit, and at once becomes surface-water. On reflection, it must be seen that the idea of such a thing as a syphon in a porous rock is out of the question, and especially one that can yield several million gallons of water a day for several weeks from a supposed reservoir of the existence of which there is no evidence, and which indeed could hardly exist in such a rock as the Chalk.

One observer, Mr. B. Latham, by long-continued persistent gauging of wells in the neighbourhood of what is known as the Croydon Bourne, has been enabled, from the gradual rise of the water-level in these wells, to predict the day on which that bourne would rise. The same thing might be done in other cases, in some more easily perhaps than in the Croydon example, as in some bourne-valleys there are many shallow wells along the bottom. There is, therefore, an opening for any one who is desirous of being enrolled amongst the prophets.

For the following old notices of Kentish nailbournes I am indebted to Mr. Latham's paper "Croydon Bourne Flows,"(1) and it will be convenient to take them together, instead of under the headings of the various bournes.

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[1] 8vo, privately printed, 1903. Also included with *Proc. Croydon Nat. Hist. Soc.*, 1904. pp. 2, 3, 5, 7–11.

In the "Chronicle" of the REV. J. WARKWORTH, which refers to the first thirteen years of the reign of Edward IV., and was published by the Camden Society in 1839, it is recorded that in 1472 bournes broke out in various places, "one at Lavesham (Lewisham) . . and another byside Canterbury (?Petham Valley) called Naylborne."

In LELAND's "Itinerary," which was begun about 1538, there is a reference to the Drellingore outbreak, "Ther is also a great spring . . that ones in a vi or vii Yeres brasteth owt so abundantly, that a great part of the water cummeth into Dovar stream, but els yt renneth yn to the Se betwyst Dovar and Folchestan" (Ed. 3, vol. 7, p. 127), a clear reference to Lydden Spout. There is also a reference to "the Nailbourn near Canterbury" (Petham Valley) on p. 168.

In "A Topographe or Survey of the County of Kent" by R. KILBURNE, published in 1659, it is said: "In the year 1472 in the park in this parish (Langley) did newly break out the bourne or spring there" and the Lewisham flow is also referred to.

The REV. J. CHILDREY seems to have had a very good idea of the primary cause of bournes. He says:—"That the sudden eruption of springs in places where they use not always run should be a sign of dearth is no wonder. For these unusual eruptions (which in Kent we call Nailbournes) are caused by extreme gluts of rain, or lasting wet weather (witness the year 1648 when there were many of them) in which years Wheat and most other grain thrive not well (for a plain reason) and therefore dearth succeeds the year following."(1)

In HARRIS' "History of Kent," published in 1719, reference is made to several bournes. Of the Alkham one it is said: "In this parish is an Eylebourn rising in a bottom, at a place called Dillingdore (Drillingore), whose Irruption the Inhabitants will have to be a certain presage, either of some great Mortality, or Dearth. . . Indeed from no apparent Head or Spring, it sends out sometimes such vast Quantities of water, that a Vessel of considerable burden may be borne by the Stream, which usually goes down to Chilton." We may be allowed to doubt about the vessel.

Of Addington, near Maidstone, he says: "Here is an Eylebourn . . which people call Ere-well, breaking out one in Seven or Eight years . . When it comes they dig a Dyke for it and turn it along by the Highway-side; and when the water mingles with that of their little Trout Rivulet it makes those Trouts Red, which otherwise are White."

He also notes outbreaks at Ospringe, in 1674 and in 1712, the latter "about a hundred yards above the Spring-Head" as well as others already noticed.

In the "History of Kent" by E. HASTED (1798) there are references to flows in the Valley of the Little Stour, at Bishopsbourne, Kingston and Barham, and others are also

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[1] Britannia Baconica: or the Natural Rarities of England . . 1661.

noticed. He says of the Ospringe flow that it "rises about half a mile southward of Whitehill, near Kennaways," and notes the western of the two streamlets at Boughton-under-Blean as a nailbourne.

We will now deal in the first place with the intermittent streams of the Chalk, and then with those of the Lower Greensand, those two being the only permeable formations of the county that form a tract broad enough for the occurrence of bournes.

Alkham Valley (The Dour).

The visible sources of the Dour, under ordinary circumstances, are at Watersend, in that part of the valley S.E. from Lydden, and from Bushey Rough in the Alkham branch, in which latter valley there is a well-known nailbourne.

Mr. W. Topley has noted that the Dour rises generally at Chilton (S.W. of Ewell), but sometimes, after wet seasons, a stream runs from further up the valley, rising at Drillingcour (Drellingore of the newer map, S.W. of Alkham) and occasionally, but only after a very wet season, at Stanley Farm (Lower Standen of the newer map), half a mile higher. At Wolverton (N.N.E. of Alkham) the water rises in the wells before the nailbourne starts, but it bursts out at Drillingcour two days before it reaches the surface at Wolverton, and at West Alkham (South Alkham of the newer map), between those places, it rises to the surface before the surface-flow from Drillingcour reaches there.(1) It is clear then that this stream is intermittent.

In 1898 Mr. Stilgoe (then Water Engineer at Dover) noted that the stream had risen at Lower Standen three times since 1852, the last time being early in 1877, and that it rises much more frequently at Drellingore, for instance in 1877, and in each year until 1883, when it broke out twice.

From a paper by Gen. Field, read to the Dover Field Club at about the end of April, 1888 (2) we learn that a description of this stream was given in the *Dover Express*, of March 3, 1883. "On that occasion the flow of water continued for several weeks" and it did not come on again until 1888. Then Gen. Field tells us that it "reappeared with full force just at Easter time and is now flowing with a considerable stream . . Drillingcour spring rises in a deep depression in a grass field . . The area covered by water is almost two acres, and the depth in some parts probably 12 to 15 feet. The overflow of water passes down the valley in a stream, running at some three to three and a half miles an hour, in a volume increasing to two feet six inches (wide) by three inches deep, equivalent to a supply of . . 407,376 gallons per diem. Reaching S. Alkham the volume of water is added to by other similar springs, which burst out simultaneously, flooding the gardens and sometimes the cottages. . Crossing

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[1] Geol. Survey Memoirs, vol. iv., p. 392 (1872).

[2] *Hythe and Sandgate Advertiser*, May 5.

the fields by a cut, the stream takes the main road as its course for a quarter of a mile to Ch. Alkham, where it turns into the cut channels, and passes on through two fields to Wolverton—a good deal of water is probably absorbed during its course through these fields—but at Wolverton it receives a large accession from another abundant spring of the same character as that of Drillingcour, and a fresh supply at Chilton Farm."

"Drillingcour spring is said to have some connection with Lydden spout," but as the former flows out at from 200 to 220 feet above sea-level, and the latter at about 20 the author seems to doubt this. As a matter of fact the two are in independent areas of drainage, separated by hills. "At Lydden village [nothing to do with the Spout, and about three miles N.N.E. of Drellingore] the wells have risen concurrently with the outburst of Drillingcour a considerable height. . . At Alkham, Drillingcour, and Wolverton, the water in the wells has risen to the same level as the overflow from the springs . . The . . tradition amongst the old people in the Minnis is that the spring recurs about every five or seven years, but that when a long continuance of S.S.W. winds has prevailed during the winter, the pressure on the sea coast and cliff squeezes the water out of the inland hills and valleys and produces the phenomenon, whereas N. and N.E. winds do not produce that pressure, and the pump remains dormant. Unfortunately for this theory the winter of 1887-8 has been remarkable for prevalence of N.E. winds." This is a good illustration of the curious theories that have been advanced to explain the occurrence of bournes.

Mr. Stilgoe noted, in 1898, that the nailbourne had broken out several times since 1888, amongst others in 1889, 1893 and 1896.

Mr. C. Buckingham has given the latest account of this nailbourne(1) and he reports as follows:—On December 12, 1903, the hollow at Drellingore began to fill and in a few days reached a height of 15 ft. and formed a stream 200 yards long. On December 17th, water began to rise in the dyke about a mile lower down the valley, and a stream soon flowed which reached up to South Alkham on the 20th. On the 22nd the Drellingore stream joined this. The stream flowed for a few weeks and then dried rapidly.

The streams rising from the springs at Mongeham and Eastry, which joint midway, have been so artificialised that one can say little of them under this heading; but their springs are noticed on p. 34.

The North Stream.

The above is the name given on the Ordnance Map to the stream which joins the Stour just below Sandwich, but I

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[1] *E. Kent Sci. N. H. Soc. Repo* ser. ii., vol. v., 1905, p. 13.

doubt whether this title can rightly be given to the whole stream. However, we are now concerned only with its two branches, on the south and on the north, and these have somewhat the nature of nailbournes.

On January 21st, 1907, I found that whilst the stream at Northbourne started at the bridge, about half a mile N.E. of the Abbey Farm, yet there was a little water at points higher up, and indeed for a short distance just below the farm, there was again a stream. In wet seasons this is probably continuous.

In the other branch, from Eastry, the stream starts in the watercourse that flows across the northern branch of the valley about five-twelfths of a mile N.E. of the church, but there was a little water (then and in April), in a few places higher up, the highest being in the pond (mostly dry) eastward of the church. Here too, in wet seasons there is probably a continuous stream, and the name Brook Lane points to its having sometimes a still higher start.

The Little Stour.

Here again, the first notice I have to give is from the notes of Mr. Topley,(1) who records that "a spring rises somewhere south of Elham every five years or so, and there are periodical springs in nearly every field for miles along the foot of the Chalk-escarpment at the same interval, and lasting for three months (February to April), all appearing and disappearing within a few days of each other."

In dry seasons I have seen the stream lost below Bridge and rising again between Bekesbourne and Littlebourne, or more than a mile lower down its course.

Mr. Topley has noted a flow in the Elham Valley in December, 1892. In February, 1900, I saw water a little eastward of Newbarn, or nearly two-thirds of a mile southward of Lyminge Church, and lower down between Broad Street and Eastbrook Farm, just west of which latter place is a spring.

In 1905, Mr. C. Buckingham recorded the following facts(2):—In 1902, the wells in the Elham (upper part of Little Stour), and Petham nailbourne-valleys were dry. They were 60 or 80 ft. deep, and the saturation-level had fallen over 80 ft. or more below the valley-bottom. The heavy rains of 1903 caused the saturation-level to rise gradually from the spring-time onwards until in December some of the wells overflowed, water issued at points along the valley-bottom and soon flowed along the whole course. The first place from which water issued (in the Valley of the Little Stour) was from the two springs in Bourne Park, in July. Above Bourne Park, the stream seems to have been intermittent, as though flowing strongly through Barham, it had not got far beyond

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[1] Memoirs of the Geological Survey, vol. iv., pp. 591, 592 (1872), where however, "north" is put instead of "south."

[2] *E. Kent Sci. N. H. Soc. Report*, ser. ii., vol. v., pp. 12, 13.

(?above or below). The nailbourne came through Barham on December 25th, and flooded between Barham and Elham on January 9th. "On January 15 this stream reached the springs in Bourne Park, and was flowing along the whole course the first time for seven years."

I am not sure that Mr. Buckingham is right in saying that the higher part of the stream at Etchinghill starts in Gault, apparently it is from Lower Chalk.

By the end of January, 1904, the water began to sink and the stream fell off considerably in a month, and on May 29th, the course was dry from North Elham to Barham. On June 30th, the flow through Barham ceased, but it continued, though getting more feeble, from Bourne Park for three months. One of these ceased on December 4th, 1904, and the other in the second week of January, 1905.

A villager gave the following dates for the last four times that the stream flowed through Bishopsbourne:—January 14, 1893, January 5, 1895, January 3, 1897, and January 15, 1904.

In an earlier paper, Mr. Buckingham notes the end of the dry course, at Bekesbourne, saying that "near the ruins of Well Chapel, in the shelter of some trees, is a spring, which starts a stream for the remainder of its journey."(1)

The Petham Valley.

In G. Dowker's paper some old notices of the bourne in this valley are given by T. Page and J. Reid as follows.

The nailbourne came into Shalmsford Street, February 22, 1772, and continued till June 16. It came again March, 7, 1774, and continued till June 28. Again, on January 12, 1775, and February 26, 1776. "This nailbourne ariseth at Dean, in the parish of Elmsted, and at Duck Pit in the parish of Waltham." From other data it came in January 1860, February, 1861, 1864 to June, 1865, and slightly in 1866, 1869 and January 1873.(2)

The first year that I was working on the Geological Survey round Canterbury (1863?) this valley, which joins that of the Stour at Shalmsford Street, Chartham, was dry throughout; but the next year (after a wet season), water was running down its gravelly bottom from Petham with great rapidity, and the water in all the neighbouring wells had risen so that where in some cases it was generally about 40 ft. down, it could then be got by dipping, either with the hand or with a pole.

In 1879, Mr. W. H. Hammond wrote on this nailbourne: (3)

"The Petham Nailbourne is chiefly fed from a number of springs which rise in a pond close to the village, but on some occasions, after a very rainy time, the springs break out at Duck Pit Farm [? Heathe Farm of the newer map], about

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[1] *E. Kent Sci. N. H. Soc. Rep.*, ser. ii., vol. iii., p. 16 (1903).

[2] *Geol. Mag.*, 1887, pp. 209, 212.

[3] *22nd Rep. E. Kent N. H. Soc.*, p. 22 (1880).

a mile further up . . and on very rare occasions at Dean Farm, two or three miles further up. It follows the course of the Petham Valley, and used to empty into a stream at Shalmesford Street . . . but of late years it has been turned into a small pond at Perry Farm, where the earth is sufficiently porous to let it drain away. The Nailbourne does not run at regular intervals nor for any regular time, but it generally begins about January, after a wet autumn and winter, and runs till about the middle or end of the summer. In 1860, it ran all the summer, which was very wet and on through the winter and spring, but until recently, it was not known to have run for more than two years in succession." He repudiates the old syphon-theory and adopts one of super-saturation of the Chalk. "After heavy rains and before the Nailbourne breaks out, the water in all the wells in the Petham Valley rises considerably, and people who live in the village can tell by the length of rope they have to let out to reach the water when the springs will rise in the pond."

An account of a later outburst has been given by MR. BUCKINGHAM(¹) according to whom it was more or less simultaneous with that of the Little Stour. The hollow near Petham Church began to fill on January 9, 1904, overflowed on January 26, and occupied the road to Swarling House [? Farm] on February 13, after which it gained only another 80 yards. It ceased on July 26. He records also that it flowed in 1897.

The Ospringe stream is intermittent. The watercourse at the village has been dry, and on the other hand, it has been flooded. In 1893, the water was exceptionally high at the Mill. Higher up, just above Whitehill, there is rarely no water.

In the great flood (1890), there was water all along the valley from Charing Hill, the ground being frozen hard and much snow thawing. It is said that there was a like flood nearly 70 years earlier. This, of course, was not due to the outbreak of springs, but to exceptional surface-conditions. The Doddington Valley was similarly affected.

Others of the North Kent streams, east of the Medway, may be of the nature of Nailbournes, but I have no notes as to this. Westward of the Medway, there are no Chalk-streams till we pass Gravesend. Then at Swanscombe is a short stream that has been artificially made into a Nailbourne (see Addenda).

MR. J. LUCAS has recorded a flow in the parishes of Eynsford and Shoreham, saying: "in July, 1874, a bourne broke out in the Austin valley below Romney Street, and flowed down the valley with great violence, demolishing a wall and doing other damage to the farm-buildings at Upper Austin Lodge . . . the water sank below the surface lower down the valley."(²) This part belongs to the Darent.

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[1] *E. Kent Sci. N. H. Soc. Report*, ser. ii., vol. v., 1905, p. 13.
Proc. Inst. Civ. Eng., 1877, vol. xlvii.

The Cray.

This river rises in a set of Chalk-springs just northward of the village of Orpington, of which seven are marked on the Ordnance Map (Kent, Sheet 16), and the cessation of some of the higher springs has led to the inference that the pumping-station made by the Kent Water Co. a little southward of that village (see p. 62) has been the cause of the lowering. It must be remembered, however, that there are also natural causes at work and that this stream is, for a short distance of the nature of a nailbourne.

I have known it for a very long time, but am glad to be able to give the following notes from a gentleman who was a resident in the district, DR. C. H. ALLFREY, who lived at Chiselhurst, and for a longer time at St. Mary Cray, from 1863-88, and acted as Deputy and then as District Medical Officer (writing in 1906), and who has supplemented his notes from information given by an older resident.

The actual source of the Cray is from springs in the grounds of the Priory at Orpington. When the springs are flowing the water rises in considerable volume, fills the Priory ponds and forms a sheet of water at the side of the main road. Then it is conducted under the road to the mill-head of Orpington Mill, whence it escapes as the River Cray.

The volume of the river was at one time considerably reinforced by the water from a series of springs at the upper part of St. Mary Cray. One, known as the Henrietta spring, a few feet on the N. side of the road was once the main resource of the people for some way round for drinking purposes.

Other springs occur at "Rowlands," close by, and others not far off. There were also some springs lower down the village near Snelling's Flour-mill.

The gravel-pits at the side of the road (at junction of main road and the road from Orpington Station to Locks Bottom), used to fill and overflow periodically. The water then ran down the road but the soil became waterlogged and cellars were filled.

The following dates of overflow (given by MR. J. COLGATE, a very old inhabitant), show that the period of overflow is variable:—1795, 1799, 1809, 1811, 1812, 1817, 1825-28. Full only 1841, 1853, 1866, 1873. The overflow occurred variously from once in December to once in April, never earlier than December, never later than April. DR. ALLFREY remembers the last two occasions (1866 and 1873), but there was an overflow also in 1877 and 1881. Certainly, he says, there has been no overflow since 1885. MR. BATTISCOMBE (of Rowlands), told DR. ALLFREY that he could remember only two occasions from that year in which there was any quantity of water in the pits, namely, in 1885 or 1886, and in 1904. He added that the Priory Springs began to fail and were very low all through 1901 and soon ceased to flow. The overflow in the road and the mill-head became dry, and the river itself would have been so had it not been pent up lower down, at Joynson's Mill.

The Henrietta Spring and the other springs feeding the Rowlands pond began to fail later, in February, 1902. By September, the pond was so dry that all the fish died; it eventually dried up and remained so during 1903.

In 1904, the water came back into the pond and soon afterwards the Orpington ponds began to fill. All through the summer of that year springs were running in the road of Orpington and the gravel-pits were half full. All the ponds remained full until the summer of 1905, when they began to fail again, the Priory and Orpington Mill first and then Rowlands.

The local idea was that the failure of the springs was due to the pumping of the Kent Water Co., and much heated correspondence took place in the *District Times*. **Dr. Allfrey**'s view, however, is: "That although the pumping was probably a contributory factor, the failure was principally due to the sequence of dry seasons. The correctness of this view would appear to be shewn by the fact that the springs recovered themselves after the heavy rains of 1903-4, notwithstanding the continuation of the pumping, with the increased abstraction of water required to supply the growing demands of the rapidly increasing neighbourhood and the extension of mains to new districts. The reason that the gravel-pits have never overflowed recently, although the waterlogged condition of Orpington appears to have recurred in 1904, would seem to be due to the fact that when the main sewer was constructed (within a year or so of the passing of the Act in 1875) a six-inch earthenware land-drain was put in under the sewer, for the express purpose of carrying off the excess of water at such times. The drain used to convey a considerable volume of water, which it discharged at the edge of the water at Broadrinea. This water could be seen bubbling up out of the ground, and it was impossible to prevent the cottagers from drinking it: they could not be persuaded that it was not a spring."

I need hardly say that I agree with **Dr. Allfrey**'s view as to the chief cause of variation in the volume of water in the Cray, though of course allowing, with him, that pumping has not been without effect. Moreover, it is not clear to me that the high water-level is an unmixed blessing, the flooding of roads is inconvenient and that of houses something worse, as those who have seen the Croydon Bourne will acknowledge.

The Ravensbourne.

This is also an intermittent stream, or at all events has been one, water having risen some way up the valley, where it is now dry. **Mr. B. Latham** says of it, from his own observations, that: "a flow of the Bourne occurred in the Wickham Valley in the years 1877, 1879, 1881, and 1883, and it has not flowed since the latter year, as large quantities of water are now taken from this valley for the supply of water to London and Croydon. The flow of the Bourne in this valley is usually later than in the Caterham Valley," in Surrey. Thus "the Bourne broke out in the Caterham Valley on the 12th December, 1880, but it was not until the 8th February, 1881, that it broke out in the Wickham Valley."(1)

The Lower Greensand Tract.

The occurrence of intermittent streams in Kent is not confined to the Chalk, but is shared, though to a much less extent, by the other great water-bearing formation, in which two cases have been observed.

The Loose. Of this stream MR. F. J. BENNETT remarks that it "takes its rise a little to the east of Langley Church, but of late years the course for a mile, except after heavy rains, is mostly dry . . It has a course of about five miles, during which it disappears . . at least twice, once for more than half-a-mile and the second time for more than a quarter-of-a-mile."(2)

The Shode. The same author says of this stream that it "rises as a Nailbourne . . at Newhouse Farm, Yaldham, with branch streams from Styant's Bottom, Oldbury, and Boro' Green. It is also called the Buster or Bustey, perhaps from the violence and volume of the stream when at the maximum of its intermittent flow. It has no name on the Ordnance Map."(3)

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[1] Croydon Bourne Flows, 1903, p. 21.

[2] Ightham: The Story of a Kentish Village, 1907, p. 131.

[3] Ightham: The Story of a Kentish Village, 1907, p. 2.

SUPPLIES FROM SPRINGS.

The only large supplies taken from springs are those for Maidstone and Folkestone, and neither of those towns depends only on such a supply. In the former case the springs are all outside the boundary of the town, in four parishes, and from two geologic formations: In this case there is a reason for treating all together, under the heading Maidstone, rather than for dividing them up under Aylesford, Boxley, East Barming and West Farleigh.

Folkestone. CHERRY GARDENS. In the Combe in the Chalk Escarpment just westward of Castle Hill. For the Waterworks.

Ordn. Map 305, new ser.; Geol. Map 3.

Information from Mr. H. TURNER, the Water Company's Engineer.

From the springs adits have been driven into the hill for 1,365 feet northward, when cross adits have been driven for 294 feet westward and for 176 feet eastward, the main adit then continuing a further 255 feet northward.

The flow, according to a letter of October, 1907, varies from 60,000 gallons in 24 hours in summer to 300,000 in winter. See also under Analyses.

Fordwich.

Ordn. Map 289, new ser.; Geol Map 3.

A supply from a spring here is noticed on page 277.

Hythe.

Ordn. Map 305, new ser.; Geol. Map 4.

1. HYTHE WATERWORKS.

At first the public supply of this town was got only from springs, the water of which flows out of the Kentish Rag (Hythe Beds).

Two of them are a little E.N.E. of the church.

The Town Spring is about 180 yards from the church and the East Well about 275.

In November, 1899, the gaugings of the former were at the rate of 1,993 gallons a day and those of the latter 3,700, according to the late Mr. G. S. WILKS, Town Clerk.

From July 5th, 1864, to July 9th, 1868, ten gaugings were taken, which give the time in which three gallons of water flowed from East Well. This time varied from 13 seconds on the latter date to 23 on December 7th, 1864.

In 1868 an arrangement was made by which the water of this spring was divided between the Corporation and Mackeson's Brewery, and then, from September 14th to December 29th, 1879, almost monthly gaugings were taken on a like principle, giving figures varying from 7 seconds on January 1st, 1877, to 41 on November 9th, 1870. These figures apparently refer to "half delivery" going to the Corporation.

The Blackrock Spring is a good way eastward of the town, near the municipal boundary, on the western side of the road in the Seabrook Valley, by the footpath a little below Horn Street.

According to Mr. WILKS the gauging of this spring for November, 1899, showed a flow at the rate of 23,563 gallons a day. This and the other springs must vary considerably.

About 1884 a well was made for the further supply of the town (see Saltwood) and a few years ago a still further supply was got from the Folkestone Water Co. Lately another well has been started, also in Saltwood, but not near the former one.

2. SANDGATE WATERWORKS.

The supply is got from the Upper and Lower Honeywood springs, nearer to the town of Hythe than the Blackrock Spring. They are both a little north of the high road, the former, where the works are placed, about 600 yards westward of the road up the Seabrook Valley and the latter about 160 yards. This overlapping is curious.

Loose.

Ordn. Map 288, new ser.; Geol. Map 6.

Dr. R. D. SWEETING's Report to the Local Government Board, 1903.

In the village-part of the parish " springs form the chief source of supply. Some of these are situated at the roadside, in positions inconvenient of access, and are exposed to contamination from soakage through cultivated and manured land. But most of the spring water is piped to dipping places, which are as a rule well-protected; though others are open and liable to pollution." There are a few shallow wells.

In the rest of the parish wells from 30 to 70 feet deep are sunk in the Kentish Rag.

Lydd. For the supply of Littlestone-on-Sea and New Romney.

Between the railways, over 1¼ miles S. of E. from the church. 1906?

Ordn. Map 321, new ser.; Geol. Map 4.

These small works were made to tap the water which finds its way out in the springs close by, and it may fairly be taken as a spring-supply.

Communicated by Mr. A. F. PHILLIPS.

About 17 feet above Ordnance Datum.

A shallow well was made on Denge Beach, wholly in shingle, a little more than a mile from high water mark of the nearest part of the sea. It is in one of the hollows and consists simply of a cast iron cylinder, 12 feet in diameter, sunk into the beach about 5 feet, and with a cover.

In April, 1907, the well had been giving a supply to the district for about 15 months, varying from 107,000 to 300,000 gallons a week, this being the requirement of the district up to the time; but a much greater quantity could be got.

Maidstone.

Ordn. Map 288, new ser.; Geol. Map 6.

1. MEDWAY BREWERY.

According to the MSS. of Sir J. PRESTWICH they used to get a supply from springs thrown out from the Kentish Rag by the underlying clay westward of the town; but the yield of these decreased.

2. WATERWORKS.

The springs formerly taken for supply and those still taken are in various parishes, and it is convenient in this case to take them all together, under the heading of the place supplied, rather than to split them up according to their varied sites.

The undertaking of the Maidstone Water Co. includes, I believe, the largest spring-supply in the county, the total yield being at the rate of more than half a million gallons a day, from springs in the Lower Chalk.

In the following table, the top two sets of springs are from the Lower Greensand, and their water was condemned as liable to pollution, whilst the bottom two sets are Chalk-springs, yielding good water. Analyses of the various waters are given on pp. 274-277.

The yield of the springs that supply, or once supplied, Maidstone are given in the Report to the Local Government Board on the Epidemic of Typhoid Fever, 1897. *Lond.* 1898, p. 6, as follows:—

In West Farleigh Parish	Ewell	1,540,000	1,680,000 gallons a week.
	Tutsham in Orchard	105,000	
	Tutsham in Field	35,000	
In East Barming Parish	Big church springs, S.E. Railway	105,000	1,155,000 gallons a week.
	Other S.E. Railway springs	1,050,000	
In Aylesford Parish	Cossington No. 1	1,325,000	2 475,000 gallons a week.
	" " 2	725,000	
	" " 3	425,000	
In Boxley Parish	Boarley No. 1	314,616	1,589,232 gallons a week.
	" " 2	514,616	
	" " 3 and 4	760,000	

Although the matter is now one of past history and the offending springs have been abandoned, as a result of the Local Government Board enquiry, so that the Maidstone Company is supplying a good and pure water from the above-mentioned Chalk springs, supplemented by a well in the Lower Greensand (see p. 88), it may be profitable to notice the admirable Report from which the above statistics are taken. It gives a very full account of the epidemic and affords a good illustration of the dangers that lie in wait for Water Authorities. The following remarks are from pages 17-19, 22, 27, 30, 31, 33:—

"The fact is that both the Tutsham [West Farleigh] and the South Eastern [East Barming] springs are derived from more or less shallow sources in the Ragstone, which is liable to be fissured, and that the gathering grounds of some of them are covered with hop or fruit gardens, which are heavily manured, and on which great numbers of persons are employed at certain seasons of the year. The land on which the springs are situated does not belong to the Company, who apparently have no control over the surface." One "of the springs flows from a bank within half a mile of the village of Barming, and within three hundred yards of a churchyard."

"So far it has been shown that though some of the Farleigh sources of supply [meaning the springs, the water of which was taken to what are known as the Farleigh works] can be considered to be safe from contamination by foul matter deposited on the surface of the ground, yet there is no direct evidence that any of them received the specific pollution of typhoid fever."

No sample, however, was taken for analysis until September 19th, at which time "the infective material causing the fever had . . greatly diminished in amount," and Mr. M. A. Adams and Dr. Washbourn (who respectively made the chemical and bacteriologic examination) believe that "had the analysis been made between August 28th and September 9th, more abundant evidence of pollution would have been forthcoming, and there would have been a greater chance of discovering the specific micro-organism associated with typhoid fever."

After reviewing the whole of the chemical evidence given at the Enquiry, the Inspectors report as follows:—

"Consideration of all the chemical data adduced leads to the conclusion that on September 19th, as also on some subsequent occasions, the water supplied [from the above-noticed sources] was found, on chemical analysis, to be in a condition indicative of its having undergone dangerous pollution; while a like conclusion is indicated as regards many of the individual springs forming the sources of supply."

Whilst the local incidence of fever in the borough points to the Farleigh supply as the cause attention is drawn also to the fact that of the "45 cases which occurred in the rural district, no fewer than 42 were stated to have resided in houses supplied by the Farleigh water, or to have drunk that water."

Finally, in the Conclusion of the Report, the following remarks occur:—"On a review of the whole of the evidence, we have no hesitation in coming to the conclusion that the epidemic was caused by the pollution of the water supplied by the Maidstone Company from their Farleigh sources."

"The chemical analyses of samples of water taken from some of the springs after the epidemic broke out show that the Farleigh supply had been dangerously polluted; and the bacteriological examination of the samples from two at least of the springs afforded conclusive evidence of excremental pollution by man or the lower animals."

Nevertheless "many of the cases of typhoid fever . . were due to defects of drainage and sewerage, with consequent pollution of the soil underlying the town," so that the Town Council has to share the responsibility with the Water Company.

Our last quotation is that "it has to be borne in mind that detection of specific pollution of a supply may come too late to prevent the consumption of the contaminated water. Clearly chemical analyses and bacteriological examinations should be supplemented by skilled inspections of the actual conditions, geological, topographical, and sanitary, of the surroundings of the sources of supply."

In an Appendix full details of the method in which the water was taken from the springs is given, the Farleigh system, now abandoned, being treated on pp. 80-83, with eight plates. From the account of the springs still used, the following particulars are taken (p. 83):—

The Boarley supply is got from four sets of springs, all on the Boarley Estate.

1. Is in a wood at the far east of the estate, and headings are driven into the Chalk to collect the water.
2. Is about 200 yards to the west, with a heading 1,000 feet long.
3. Is the most westerly, and
4. Is in a field north of Boarley Farm and has headings.

The Cossington supply is got from three sets of springs (1) on the east; (3) on the west; and (2) between.

Both these works were made in 1886; but I believe that they have been extended.

PENSHURST WATERWORKS. 1902.

Ordn. Map 287, new ser.; Geol. Map 6.

Communicated by Mr. T. HENNELL, who designed the works.

The supply is got from a spring at Tubb's Hole, S.E. of the farm called Coldharbour (and about 1½ miles S.S.W. of the church). It is on the southern side of a narrow valley a short distance from and a little above the stream.

The ground is on Tunbridge Wells Sand, in great part rock.

The spring when gauged in the summers of 1900 and 1901 never fell below 14 gallons a minute.

A well was sunk near the spring, to about 10 feet below it and two headings, each 20 feet long, 6 feet high and 4 feet wide, were made in the bottom.

Water has been pumped ever since the work was finished, and the consumption has gradually increased to 9,000 gallons daily. The water in the well is lowered only 5 feet by the pumping, and never yet to the top of the headings, which have been full ever since construction. The spring begins to flow again a few hours after the cessation of pumping. The maximum supply available in dry seasons is reckoned at about 20,000 gallons a day.

The following gaugings have been communicated by Dr. F. **Parsons**, who describes the spring as rising in pasture-land at the junction of the Tunbridge Wells Sand and the Wadhurst Clay :—

August 13th, 1896 ...	14	Gallons a minute
,, 30th, 1897 ...	20	
October 29th, — ...	20	
,, 2nd, 1900 ...	16⅔	
September 9th, 1901	16⅚	

Tunbridge Wells.

Ordn. Map 303, new ser. ; Geol. Map 6.

According to Scudamore's book of 1816, Dr. T. **Thomson** says that a supply was got from " an excellent spring of very fine water, which rises about a quarter of a mile to the south of the village, bursting out of a field on the side of the hill." It was collected in an open reservoir and taken on by leaden pipes. The " village " has got beyond a supply of this sort, but I believe gets part of its supply (at Pembury) from springs.

Ulcombe.

Ordn. Map 288, new ser. ; Geol. Map 6.

From Dr. **Mivart**'s Report to the Local Government Board on the Hollingbourn Rural District, 1908.

" At Pye Corner . . a small water scheme was inaugurated some 13 years ago. Water flows [from a spring] to a closed reservoir and thence by gravitation to the hamlet. Some few years ago this supply gave out," and the Mid Kent Co. now supply. " At the northern end of the hamlet . . a supply of water from a private spring is conveyed to a standpipe."

SUPPLIES FROM WELLS.

Of course the number of wells that are not noticed in this Memoir far outnumbers those that are noticed; but it is hoped that few wells of importance have escaped. The neglected, indeed, are probably many times the number of those that can be recorded now. They chiefly fall into two classes; shallow wells in gravel, etc., and deeper wells in the Chalk. They belong mostly to individual houses or to groups of houses; many of them are very old; as a rule no records of them have been kept; many have been abandoned; in most cases the only information that can be got, from the deeper class, is concerning the water-level and its fluctuations. This certainly is valuable information; but its value depends much on the keeping of careful records for a considerable time. Engineers have made measurements for certain districts, for the purpose of establishing or criticizing various schemes of supply, and one would be glad to have copies of such measurements. Reference has been already made to published accounts (pp. 5, 6. See also 366, 367). Clearly isolated examples may be of small because only of local value; but, nevertheless, owners of wells would do wisely to keep a record of water-level.

Of the wells now to be recorded a very great number have for their object the getting of water from the Chalk, some also tapping the sands of the Lower London Tertiaries on the way. A much smaller number deal with the Lower Greensand, and yet a smaller number with the sandy members of the Hastings Beds.

In other formations there is little work of importance, Tunbridge being the only large place getting its water from a surface-deposit.

From what has gone before and from what follows it will be seen that the Chalk is the great source of water-supply for the county, all the larger towns (but Ashford, Tunbridge, and Tunbridge Wells) depending wholly or partly on this formation, and this includes the south-eastern or Kentish part of London.

Wells notable geologically, etc.

Ashford.—Brewery. Deep section of Wealden Beds and very peculiar water.

Ashford.—Henwood Waterworks. Show remarkable thinning of the Hythe Beds.

Boxley.—Forstal Pumping Station (Maidstone Waterworks), showing thickness of Lower Greensand.

Brenchley.—Great thickness of Wadhurst Clay, 195 feet.

Burham and other places in the Valley of the Medway.—Prove the depth to Lower Greensand, through Chalk and Gault.

Chartham.—Shows the depth to the base of the Chalk.

Chatham.—Dockyard and Waterworks. Through Chalk, Gault and Lower Greensand, in the former (and perhaps in the latter) to Oxford Clay.

Cliffe.—Gives a section through Chalk and Gault to Lower Greensand.

Dover.—Prison. A section through Chalk, Gault and Lower Greensand, presumably to Hastings Beds.

Erith.—Crossness. Through the Eocene and Cretaceous Series to much older rocks, of doubtful age. This and other neighbouring sections tend to prove the occurrence of a fault throwing down the beds to the north along the foot of the hills of the Lower London Tertiaries. See also Greenwich.

Folkestone.—Various sections show the thickness of divisions of the Lower Greensand.

Frindsbury.—The Chattenden boring gives a deep section through the Eocene Beds, the Chalk and the Gault to Lower Greensand. The borings of the Whitewall and of the Portland Cement Companies also show the depth to Lower Greensand, through Chalk and Gault.

Greenwich.—Various sections prove the occurrence of a fault, with northerly downthrow, as they reach Chalk at some depth, whilst it crops out on the south, near by.

Hadlow.—The Style's Place well gives a deep section in Wealden Beds, with a very peculiar water.

Hawkhurst.—The wells here show a great thickness of Wadhurst Clay, over 200 feet.

Kemsing.—Section through Lower Greensand.

Lydd.—The most easterly boring through the lower beds of the Wealden Series, in a tract where the surface consists of Recent beds only.

Maidstone.—Foley House (6). Apparently shows a great thickness of Weald Clay, over 700 feet, which is more than had been estimated. Carried through all the divisions of the Lower Greensand into the Hastings Beds.

Margate.—Dane Pumping Station. Carried through the Chalk and Gault into the Lower Greensand.

Pembury.—Wells of the Tunbridge Wells Waterworks. Sections of the Hastings Beds, showing a great thickness of Wadhurst Clay.

Rainham.—Deep boring through nearly the whole of the Chalk and the Gault, into Lower Greensand.

Seal.—Showing a great thickness of the Hythe Beds.

Sheerness.—The wells here prove a great thickness of the Lower London Tertiaries and a great depth to the Chalk.

Shoreham.—Reaches from the lower part of the Chalk to the Lower Greensand, showing only 10 feet of Upper Greensand, but 226 of Gault.

Sittingbourne.—Through the Upper and Middle into the Lower Chalk.

Southborough.—Passes through a great thickness of Wadhurst Clay, and the Ashdown Beds into Fairlight Beds, apparently.

Strood.—No. 2. Passes through a great thickness of the Chalk, and the Gault, into Lower Greensand.

Sundridge.—Shows a great thickness of Gault, to which a little has to be added, for the top beds.

Tonbridge.—Section of Tunbridge Wells Sand, with Grinstead Clay, at Hildenborough.

Tunbridge Wells.—Section of the Hastings Beds (Tunbridge Wells Sand to Ashdown Sand) at Culverden Brewery.

Wye.—Shows 185 feet of Gault, being a notable increase of thickness from the coast at Folkestone, where this formation is about 100 feet thick.

Besides the above many other well-sections prove the character and thickness of the varying divisions of the Lower London Tertiaries, and the depth, through the Tertiary beds, to the Chalk, thus giving information that is useful from more than one point of view.

Wells notable for Supply, etc.

In the first place of course come the majority of the wells of the *Metropolitan Water Board,* that is to say those at Beckenham, Bexley, Crayford, Darenth, Deptford, Farnborough, Southfleet, West Wickham and Wilmington, all getting large supplies from the Upper Chalk (see pp. 81, 85, 112, 113, 118, 133, 200, 213, 215). Besides these the following may be entered.

Ashford.—Waterworks. For records of water-levels, etc.

Boxley.—Maidstone Waterworks. For supply from the Lower Greensand.

Burham and other places in the Valley of the Medway.—For deep-seated supplies from the Lower Greensand.

Chatham.—Waterworks. For large supply from the Chalk, partly from the lower part.

Dartford and *Erith.*—A very large supply got from the Chalk, by various wells.

Frindsbury.—Chattenden Boring. Gets water at great depth from Lower Greensand, as also do other wells at less depth.

Lower Halling.—The Mid Kent Works get a large supply from the Lower Greensand, which is distributed over a very large area.

Pembury.—Works for the supply of Tunbridge Wells, the greatest supply from the Hastings Beds in the county.

Rainham.—A supply got at great depth by a boring through Chalk and Gault to Lower Greensand.

Ramsgate.—Great length of galleries needed for supply.

Sevenoaks.—Water got from the Hythe Beds (Kentish Rag) from just beneath the railway-tunnel, for public supply.

Sheerness.—Supplies got by borings through a thick mass of Tertiary beds into the Chalk. Probably much of the water comes from sandy beds in the Lower London Tertiaries.

Sittingbourne.—A supply from a deep boring in Upper, Middle and Lower Chalk.

Southborough. -A deep-seated supply from the Ashdown Beds.

Strood.—A deep-seated supply from the Lower Greensand, and a public supply from the Upper Chalk, with a natural gallery.

Swanscombe.—A large manufacturing supply from the Upper Chalk.

Thanington.—The supply of Canterbury, from Upper, Middle and ? Lower Chalk.

Walmer.—Deal Waterworks. Good supply from wells and galleries in the Upper Chalk.

Wingham.—Margate Waterworks. Good supply from wells and galleries in the Upper Chalk, for a large district.

Woodnesborough.—Supply for a large district, from the Upper Chalk.

Although the literature of Kentish wells has been kept fairly well up to date for some parts of the county, yet even in those parts many new wells have been made since the appearance of the last Memoir or paper on the subject; indeed, perhaps to such an extent as to make the accumulation of new material as great as in those parts that, for various reasons, have been less favoured in the matter of publication of records. Whilst, therefore, the majority of the following details have already appeared, in various forms, yet a substantial addition has been made, and accounts of the following wells are now printed for the first time.

Ash, Ashford (all but No. 1), Beckenham (Nos. 2, 4, 5, 6, 9), Benenden, Bexley (Nos. 3, 9, 10), Boxley (No. 2, the well), Branbridge, Brasted (both), Brenchley, Broadstairs, Bromley (No. 4), Brook, Brookland, Buckland, Canterbury (No. 3, second well), Charing (No. 2), Chatham (Waterworks, deep boring, only privately printed before, to some extent, and No. 6), Chevening (Nos. 2, 3), Chiddingstone (both), Chiselhurst (Nos. 2, 3, 4), Chislet (both), Cliffe (Nos. 2, 3, 4), Cowden, Cranbrook (all three), Darenth (all three), Dartford (all but Nos. 7, 8, 9), Deal, Deptford (Nos. 5, 6), Detling, Dover Waterworks, East Barming, Eastchurch, East Langdon, Edenbridge, Egerton, Elmsted, Erith (Nos. 1, 2, 9, 10, 12-14), Folkestone (No. 1), Foot's Cray (both), Frindsbury (No. 5), Frittenden, Goudhurst, Gravesend (Nos. 2, 5), Greenwich (Nos. 9, 10), Hadlow (No. 2), Halstead, Ham Street, Hawkhurst (all three), Herne (Nos. 1, 3), Hever, High Hockley, Hunton, Ightham, Kemsing, Kenardington, Kingsnorth, Knockholt, Lee (Nos. 2, 3, 4), Lewisham (Nos. 2, 4 ?), Linsted, Lower Halling (No. 2, second well), Maidstone (Nos. 7—9), Marden, Margate (part of No. 2), Minster, Sheppey (all), Monkton, Northbourne, Northfleet (Nos. 2, 4, 5), Oare (Nos. 3, 4), Otford (Nos. 1, 3, 4), Pembury (Nos. 1, 3—5), Pluckley, Plumstead (Nos. 1, 3, 6), Rainham (No. 2), Rochester (No. 5), St. Paul's Cray (both), Saltwood (No. 1), Seal, Sevenoaks (Nos. 1—4), Shorne (No. 1), Southborough, Stanford, Strood (Nos. 4, 5), Sundridge (No. 1), Swanscombe, Tonbridge (all four), Tunbridge Wells (all four), Wateringbury, Westgate, Wickhambreux, Wingham (both), Woodchurch, Woodnesborough.

Also, added since the above was written, Capel-le-Ferne, Lydden, Murston (No. 2) and, in Addenda, Goudhurst and Hawkhurst.

DETAILS OF WELLS AND BORINGS FOR WATER.

The following accounts of wells, etc., are arranged alphabetically, by the names of the towns and villages in which the wells occur. Localities have often been given to us from the nearest village or railway-station; but as far as possible the present headings are taken from the village or town in the parish of which the site is placed, names of hamlets, etc., being kept in a subordinate position, or put with cross-references as in the first entry. The parish is the smallest unit of rural local government and clearly it is convenient to accept it.

[*Words in these brackets have been inserted by the Author*].

Abbey Wood, *see* **Erith.**

Allhallows Marshes. Near ALLHALLOWS VILLAGE, 1900. ?

Ordn. Map 272, new ser.; Geol. Map 6.
Communicated by Mr. J. H. OAKLEY.
Water rose nearly to the top of the bore. A good supply.

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
[Alluvium]	Blue clay	7	0	7	0
	Sand and peat	4	0	11	0
[River Drift]	Yellow sand	20	0	31	0
	Thames ballast [gravel]... ...	11	0	42	0
[London Clay, 198 feet]	Blue clay	158	0	200	0
	Coal of good quality [lignite]	0	3	200	3
	Blue clay	39	9	240	0
[Oldhaven Beds]	Green sand and water	4	0	244	0
	Grey sand	6	0	250	0

Mr. BIRD, in an account of this well (*Rochester Naturalist*, 1900, vol. iii., No. 70, p. 12), says that the samples from the London Clay were tough, hard, similar throughout, and with cement-stones here and there. The bottom part is described as more sandy, dark green (from glauconite-grains), with a layer of flint pebbles at the base (made 236 feet).

Ash. Messrs. GARDNER'S BREWERY, nearly a third of a mile E. of the Church, 1900.

Ordn. Map 290, new ser.; Geol. Map 3.
Made and communicated by Messrs. LE GRAND and SUTCLIFF, and from Mr. GARDNER.
66 feet above Ordnance Datum.
Rest-level of the water 65 feet below the pump-floor. Yield over 4,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Soil		4	4
[? Surface-wash or Woolwich Beds] Loamy sand, with 3 inches of pebbles at the base		9¾	13¾
[Thanet Beds, 92¼ feet]	Loamy sand	4¼	18
	Running sand	5	23
	Loamy sand	3	26
	Hard blue clay	80	106
[Upper] Chalk and flints		394	400

There is an older boring here, to the depth of 220 feet, and Mr. GARDNER believes that the pumping at the Woodnesborough Well (Sandwich Waterworks) affected the water-level at the Brewery, the latter having fallen after the establishment of the works (see p. 216).

Ashford.

Ordn. Map 289, new ser.; Geol. Map 3.

1, 2, BREWERY, 1874.

Boring made and communicated by Messrs. TILLEY, 1900. (*S.E. Naturalist*, 1902.)

		Thickness.	Depth.
		Ft.	Ft.
Old well and boring	... ...	—	267
[Weald Clay]	Green clay	33	300
	Hard veins of pyrites	15	315
	Light-coloured clay	2	317
	Green clay	35	352
	Hard sand-rock and pyrites ...	6	358
	Green clay and beds of stone ...	24	382
	Hard white stuff...	2	384
	Red clay	2	386
	Dull blue clay	14	400
	Clay and hard stony stuff ...	36	436
	Clay	18	454
[? Tunbridge Wells Sand]	Sand-rock...	30	484
	Chocolate-coloured clay ...	4	488
	Clay and sand-rock	9	497
	Sand-rock, hard and soft veins	3	509
	Hard sand-rock	14	514
	Dirty sand and brown stuff ...	34	548
	Chocolate-coloured clay ...	2	550
	Sandy stuff	20	570
	Hard white substance	¾	570¾
[? Wadhurst Clay]	Dull brown clay	30¼	601
	Hard sandstone	4	605
	Brown clay	9	614
	Hard sand and pyrites	2	616
	Brown clay	4	620
	Rock	6	626
	Light-coloured clay	23	649
[? Ashdown Beds]	Sand-rock...	9	658
	Light-coloured clay	6	664
	Sand-rock...	30	694
	Coloured [mottled] clay... ...	17	711
	Soft sand-rock, with water ...	2	713
	Green sandy clay	5	718
	Hard white stuff...	3	721
	Green clay	1½	722½

This boring was all right at first, with plenty of water, which stood within 50 feet of the surface and could not be lowered; but it failed after a time, ? from the hole, which is only of 1½ inches diameter at the bottom, getting choked. A second boring was therefore made.

Second Well, 1901.

Made and communicated by Messrs. Isler & Co.

195 feet of tubes, of 6 inches diameter, 15 feet down; 400 feet, of 5 inches diameter, 195 feet down; 390 feet, of 4 inches diameter, 333 feet down.

Water-level 54 feet down. Supply good (in quantity) but the water unusable (see Analyses, pp. 285-287).

		Thickness.	Depth.
		Ft.	Ft.
Well (the rest bored)		—	95
[Weald Clay]	Blue clay	42	137
	Blue clay and rock	5	142
	Rock	5	147
	Clay	12½	159½
	Red clay	4½	164
	Clay	60	224
	Quartz [?]	½	224½
	Grey clay	20	244½
	Red clay	16	260½
	Brown clay	4	264½
	Grey clay	24	288½
	Grey rock	10	298½
	Grey and dark clay	26	324½
[? Weald Clay and Tunbridge Wells Sand]	Grey rock	24	348½
	Grey clay	10	358½
	Grey rock	8	366½
	Red and grey clay	14	380½
	Grey clay	30	410½
	Grey rock	10	420½
	Grey clay	12	432½
	Grey rock	8	440½
	Dark clay	18	458½
	Grey rock	9	467½
	Grey and dark clay	15	482½
	Grey rock	6	488½
	Clay	12	500½
	Grey rock	9	509½
	Grey sand	1½	511
	Clay	10	521
	Grey rock	6	527
	Clay	22	549
	Grey rock	13	562
[? Wadhurst Clay]	Grey clay	3	565
	Brown clay	6½	571½
	Grey clay	20	591½
	Dark brown clay	24	615½
	Grey sandy clay	12	627½
	Grey clay	14½	642
	Dark brown clay	20	662
	Grey clay	8	670
[Ashdown Beds 112 feet]	Sand and clay	53	723
	Light-blue clay	3	726
	Light-grey rock	10	736
	Hard rock and clay	7	743
	Light-coloured soft sand with bands of rock	12	755
	Light-coloured soft sand	25⅓	780⅓
	Hard grey rock	1⅔	782

This section gives details between 95 and 267 feet that were not given by the earlier section, and it continues the section to a further depth of 59½ feet.

3. Railway Waterworks. By the edge of the marsh. At the eastern side of the Canterbury line a third of a mile north-eastward of Henwood.

A well of about 40 feet, presumably through the Sandgate Beds to the Kentish Rag.

4. Sewage Works, on the marsh, two-thirds of a mile north-east of the Church.

A well of 18 feet, with a boring of 18 feet, presumably through Alluvium into gravel. Possibly Kentish Rag may have been reached. Water, from the boring, to within 3 feet of the surface.

5. South Eastern Railway Works, 1903?

Made and communicated by Messrs. Isler & Co.

Lined with 480 feet of tubes, of 7¼ inches diameter, up to the surface. Water-level 60 feet down. Supply 600 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Dug well (the rest bored) ...		—	8
[Weald Clay]	Blue clay ...	115	123
	Light-blue clay and layers of limestone...	28	151
	Light-coloured clay ...	10	161
	Light-coloured clay and limestone	4	165
	Light-coloured and dark clay ...	15	180
	Mottled clay ...	5	185
	Blue clay and layers of rock ...	12	197
	Blue clay ...	12	209
	Light-coloured clay and rock ...	14	223
	Blue clay ...	14	237
	Blue clay and fullers' earth ...	14	251
	Light-coloured and dark clay ...	5	256
	Light-coloured clay ...	10	266
	Light-coloured clay and fullers' earth...	20	286
	Light-coloured clay ...	9	295
	Mottled clay ...	15	310
	Light-coloured clay ...	8	318
	Clay and rock...	7	325
	Iron-pyrites and limestone...	5	330
	Light-coloured clay ...	26	356
	Sandstone-clay and rock ..	5	361
	Clay ...	10½	371½
[? Tunbridge Wells Sand]	Dark sandstone ...	11	382½
	Lignite (?) and sandstone ...	14	396½
	Light-grey sandstone ...	31½	428
	Grey rock ...	17	445
	Light-coloured tough clay ...	7	452
	Tough clay with layers of rock ...	12	464
	Light-coloured sandstone and fullers' earth (the water-bearing bed) ...	48	512
[? Wadhurst]	Tough clay ...	21	533

Owing to the fine nature of the sand in which the water was found it took months of pumping before the water became clear. This result was got by means of an air-lift pump, as an ordinary deep well pump proved a failure.

6. WATERWORKS. At Henwood, E. of the town, 1853 and later.

Information from Mr. W. TERRILL, Surveyor to the Council (1888,9) and from examination on the spot.

Pumping-well, at the engine-house, at the western end of the ground, 36 feet.

B. well, just west of Henwood, 24 feet.

The well for the farm, just north, is over 30 feet deep, and is said to reach rock (Kentish Rag) at 13 feet.

C. well, at the southern boundary of the ground, south-east of Henwood, over 30 feet.

D. well, at the eastern end of the ground, by lane, over 37 feet.

These wells are connected by a gallery, and D is also connected with the pumping-well by a syphon-pipe.

Unfortunately there is no record of what was passed through in these old works. The whole tract is mapped as Sandgate Beds; but the Kentish Rag must be reached by the wells and galleries, and the water comes from this. Clay is said to have been found at the bottom. If this be Atherfield Clay the Hythe Beds are abnormally thin, far thinner than one would have expected. Later work seems to show that this is the case. W. W.

D. well. Gaugings taken in the morning after the well had been standing during the night, the available depth being 33 feet 8 inches out of total depth of 37 feet 4 inches :—

	Ft.	in.	
1898, 14th July	23	6	down
1897 „	16	8	„
1896 „	20	10	„
1895 „	17	2	„
1894 „	14	0	„
1893 „	15	2	„
1892 „	12	11	„
1891 „	14	7	„

Consumption, or quantity pumped, the last fortnight, 1,960,297 gallons; for 1897, 2,256,630 gallons.

Three other shafts were made in 1899 and later, at equal intervals between the pumping-well and D, that is along the line of the syphon-pipe, information as to which has also been given by Mr. TERRILL.

1. Nearest D. 27 feet, with about 5 feet of water. Does not appear (March 20th, 1899) to be affected by pumping out well C, the water in which is at a lower level (about 5 feet).

2. Next westward, between B and C. 13 feet to rock. Slightly affected by pumping at C.

3. About 17 feet, 13 to rock.

In 1907 the total capacity of the wells and adits was 341,816 gallons.

Mr. TERRILL has furnished a diagram (deposited in the Geological Survey Office) showing, by different coloured lines, the water-levels in the morning, in the pumping-well, from April 1st, 1891, to December 31st, 1894; from January 1st, 1895, to July 24th, 1899; from November 18th, 1900, to December 31st, 1894; and from January 1st, 1905, to March 23rd, 1907. The gap between July, 1899, and November, 1900, is owing to the construction of adits, which interfered with the record. The highest record was in the early part of March, 1904, when the water overflowed to the river, and the lowest was in the early part of March, 1898, when it was about 27 feet lower (except for a curious sudden fall in July, 1899). When, however, the water was kept low (? by continuous pumping), from November, 1900, to March, 1901, a still lower level was reached. As the highest and lowest rest-levels over the whole period occur in March, it is clear that this is the time of greatest seasonal fluctuation. The least fluctuation is in August.

Mr. Terrill has also given a table of gaugings of the yield during the construction of the adits, from January 21st to November 16th, 1900. The highest amount (436,320 gallons in 24 hours) was on October 17th, and the lowest (78,298 gallons) on February 2nd.

He has further contributed the following table:—

Date.	Rainfall in inches.	Gallons of water pumped.	Level of water in pumping-well, June 22nd.		Remarks.
			Morning. Ft. in.	Evening. Ft. in.	
1893	28·61	38,633,711	14 4	31 10	
1894	38·82	39,309,386	12 7	28 10	Heaviest rainfall for 30 years, ending 1906
1895	23·83	41,037,419	15 3	19 9	
1896	29·44	39,673,997	19 11	22 7	
1897	27·21	46,245,555	18 3	17 11	
1898	22·53	45,548,396	23 1	27 9	Lowest rainfall for 30 years
1899	25·86	47,809,520	20 2	21 5	Adits commenced, August
1900	28·1	65,696,073	25 7	30 11	At D well in this case surface 10 ft. 2 in. higher
1901	23·63	69,782,129	18 2	20 8	Adits finished, March
1902	23·06	54,736,893	14 10	17 2	
1903	33·19	59,089,049	9 10	12 6	
1904	24·03	59,198,530	9 9	12 10	Feb. 29th to Mar. 3rd overflowing to river*
1905	27·17	64,709,306	11 7	14 3	
1906	—	63,116,737	11 7	16 4	

* The morning-level was 2 feet 9 inches and the evening-level 5 feet 6 inches.

Besides Ashford parts of Willesborough and Kingsnorth are supplied. There are 1,265 feet of adits. Yearly supply for all purposes 63,116,737 gallons. (Water Works Directory, 1907.)

Barming, *see* East Barming.

Barming Heath, *see* Maidstone.

Bean, *see* Stone.

Beckenham.

Ordn. Map 270, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4, new.

1. Brickyard, about a third of a mile west of Beckenham Place.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 16½ feet]	Loamy clay ... ... about	5	5
	Strong blue clay ... ... „	10	15
	Pebbly gravel [basement-bed ?] „	1½	16½
Sand [Oldhaven Beds]		18	34½

2. ELECTRIC LIGHT STATION, 1900.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
100 feet above Ordnance Datum. Borehole of 6 inches diameter.

		Thickness.	Depth.
		Ft.	Ft.
Coloured clay		4	4
Gravel		2	6
[London Clay]	Sandy clay	4	10
	Blue clay and mundic	15	25
[? Oldhaven Beds]	Sand	16	41
[Woolwich and Reading Beds, 37 feet]	Clay, shells and pebbles	15	56
	Mottled clay	17	73
	Clay and stone	5	78
[Thanet Sand, 52 feet]	Sand	27	105
	Hard sand (almost rock)	1	106
	Sand	12	118
	Hard dry clayey sand	11	129
	Green flints	1	130
[Upper] Chalk and flints		120	250

3. ELMER'S END BREWERY, Messrs. Pontifex and Hall, 1881 ?

About 136 feet above Ordnance Datum.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Bored throughout. Water rose 4 feet above the surface. Supply 10,000 gallons a day of ten hours.

According to SIR A. BINNIE the water-level has been lowered by the sinking of a well in the neighbourhood, to 4 feet down. (*R. Comm. Metr. Water Supply*, 1893, *Appendices*, p. 169.)

		Thickness.	Depth.
		Ft.	Ft.
[Oldhaven Beds, 18 feet]	Brown sand	3½	3½
	Grey sand	14½	18
[Woolwich and Reading Beds, 39 feet]	Shells and concrete	4½	22½
	Shells and clay	7½	30
	Hard white stone	2	32
	Coloured [mottled] clays	13	45
	Black [flint] pebbles	4	49
	Green sand and black pebbles	8	57
[Thanet Sand, 53 feet]	Live grey sand	47	104
	Dead sand	4½	108½
	Flints	1½	110
[Upper] Chalk and flints		70	180

4. ELMER'S END, Messrs. Muirhead and Co.'s Electrical Factory, 1897.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
107 feet above Ordnance Datum. Borehole of 10 to 8 inches diameter.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		6	6
[Oldhaven Beds]	Yellow clay	2	8
	Grey sand	16	24
[Woolwich and Reading Beds, 38 feet]	Shell-rock	1	25
	Clay and shells	13	38
	Mottled clay	15	53
	Pebbles, clay and sand	4	57
	Green sand and pebbles	5	62
[Thanet] Sand		56	118
[Upper] Chalk and flints		115	233

Another account differs thus :—

	Thickness.	Depth.
	Ft.	Ft.
Soil	1	1
Gravel	1½	2½
Mottled clay	2½	5
Live grey sand...	18	23
Next five beds as above	—	61
Live grey sand...	35	96
Dead sand	21	117
Flints	2	119
Chalk	117	236

5. Oak Woods House, 1859?

Made and communicated by Messrs. Docwra.

Shaft 100 feet, and water rose to 30 feet above the bottom of this.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Yellow clay	29	29
	Brown sand	7	36
	Yellow clay	9	45
	Blue clay	41	86
[Blackheath Beds]	Black [flint] pebbles	28	114
[Woolwich and Reading Beds]	Blue clay...	8	122
	Oyster-rock	3	125
	Blue clay and shells	17	142
	Sandy clay	3	145
	Coloured [mottled] clay	4	149
	Green sand	12	161
	White [Thanet] sand	40	201
	Chalk	269	470

6. Public Baths, 1900.

Made by Messrs. Le Grand and Sutcliff. Communicated by Mr. T. Walker.

97 feet above Ordnance Datum. Borehole of 8½ inches diameter.

		Thickness.	Depth.
		Ft.	Ft.
[? Drift]	Ballast ...	6	6
	Clayey gravel...	4	10
[? London]	Clay	8	18
[? Blackheath Beds]	Black pebbles...	8	26
	Shell-rock	1½	27½
	Pebbles	½	28
	Shells and sand	1	29
	Live sand	8	37
[Woolwich and Reading Beds, 33 feet]	Clay, shells, and stone	15	52
	Mottled clay ...	3	55
	Mottled clay and stone	3	58
	Mottled clay ...	4	62
	Pebbles	2	64
	Conglomerate of pebbles, sand, and clay ...	6	70
[Thanet Sand]	Sand ...	57	127
	Green flints ...	2	129
[Upper Chalk]	Chalk and flints	11	140
	Hard chalk ...	27	167
	Chalk and flints	133	300

7. SHORTLANDS, at the house on the hill just west of the Railway Station (Mr. Wilkinson's), Clay Hill, 1857.

About 178 feet above Ordnance Datum.

Communicated by Mr. R. B. LATTER.

Shaft about 59 feet, the rest bored. Water about 61 feet down. 24,000 gallons pumped in 24 hours.

According to Sir A. BINNIE there was a loss of 14 feet in the water-level in 4 years, the well never having recovered since the drought of 1887. Pumping, for a few hours a day, does not appreciably reduce the water-level. (*R. Comm. Metr. Water Supply*, 1893, *Appendices*, p. 169).

		Thickness.	Depth.
		Ft.	Ft.
Sandy loam [? Surface-earth, or London Clay] ...		10	10
[Blackheath Beds]	Gravel, 10 feet ... ... Clayey gravel, [? varying up to] 21 feet	22	32
[Woolwich and Reading Beds, about 51 feet]	Blue clay, with shells of *Ostrea* and of *Cyrena* in fragments, partly conglomerated ... about	13	45
	Pebbles.		
	Mottled clay... ... ... about	6	51
	Gravels, with *Ostrea*; of a green colour [clayey green sand with pebbles; "bottom-bed"] about	10 [? more]	61
[Thanet Sand, about 48 feet]	White sand ... ... Marly sand ... ... Sand, more marly ... ... Dark-greenish marly sand, more marly at bottom ... about	48 [? more]	109
	Detritus of flints [? the usual green-coated flints at the bottom of the Thanet Sand].		
Chalk, with flints (some thick)		100	209

8. WATERWORKS (Metropolitan Water Board), close to the Shortlands Railway Station, 1864. Second well, 1873.

About 130 feet above Ordnance Datum.

Communicated by Dr. W. FARR. Some particulars by Mr. J. LUCAS (*Journ. Soc. Arts*, vol. xxv., p. 608.)

Shaft 100 feet, the rest bored.

Water-level (April, 1877), before pumping, 8 feet down; after pumping, 18 feet.

The engineer said that he could pump 5,000,000 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
[Thanet Sand]	Clean sand [? including gravel]	60	60
	Marl [? clayey sand]	10	70
White Chalk		180	250

An account from Messrs. S. F. BAKER & SONS, who sunk the well, is a little different, being as follows:—

Gravel, 6 feet; [Thanet] sand, 58 feet.

From the Engineer's Report (W. Morris), furnished by the Kent Water Co. to the Water Board Arbitrators (1903), we learn that there is a third well, and get the following additional particulars:—

The second well is 70 feet deep and bored to 250.

The water-level is about 10 feet down when the engines are at rest, and is lowered to about 37 when both engines are pumping continuously.

The yield is then 2,250,000 gallons in 24 hours, the water coming from the two boreholes.

9. Victoria Laundry, Avenue Road, 1907.

Made and communicated by Messrs. R. Richards & Co.

Water-level 14 feet down; when pumping at the rate of 2000 gallons an hour the level kept the same.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Clay	25	25
	Blue clay	50	75
[Blackheath Beds, 17½ feet]	Sand and gravel [pebbles] ...	6	81
	Running sand	10	91
	Rock	1½	92½
[Woolwich and Reading Beds, 39½ feet]	Clay	2	94½
	Fossil and hard clay	5½	100
	Hard clay	10	110
	Mottled clay	3	113
	Hard clay	7	120
	Sand and gravel [pebbles] ...	4	124
	Sand	2	126
	Green sand and gravel [pebbles]...	6	132
[Thanet Sand, 49 feet]	Sand	5	137
	Running sand	3½	140½
	Soft sandstone	½	141
	Running sand	21	162
	Sand and fine gravel [flints] ...	17	179
	Green gravel [flints]	2	181
Chalk and flints		69	250

Bell Green, *see* Lewisham.

Belvedere, *see* Erith.

Benenden. East Benenden, 1906.

Ordn. Map 304, new ser.; Geol. Map 5.

Made and communicated by Messrs. Duke and Ockenden.

Water-level 6 feet down.

		Thickness.	Depth.
		Ft.	Ft.
	Yellow clay	19	19
	Hard sandstone	5	24
[Wadhurst Clay]	Hard green and blue sandy clay	16	40
	Blue clay...	16	56
	Brown clay	6	62
	Blue clay...	22	84
	Grey rock	3	87
	Blue clay...	44	131

Betteshanger *see* Northbourne.

Bexley.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4, new.

1. BREWERY. Messrs. Reffell's.

Made and communicated by Mr. W. R. REFFELL.

Shaft nearly 6 feet, the rest bored, with pipes to 80 feet.

Water-level in the gravel about 5½ feet down; from the Chalk 2½ feet down. It rose to this level when the Chalk was touched, and remained at it afterwards. Pumped, for 14 hours, 50 barrels an hour. Supply good and apparently inexhaustible. Temperature of the water 52° F.

		Thickness.	Depth.
		Ft.	Ft.
Gravel, waterlogged		18½	18½
[? Thanet Beds]	Sandy clay or loam, impervious to water	16¼	34¾
	Flints	½	35¼
[Upper] Chalk	Soft chalk, with beds of flints, and with water ...	39¾	75
	Hard chalk	98	173

Before this well was made the Brewery was supplied from a well, 12 feet deep in the gravel. From this the same quantity was pumped as noted above, never reducing the level of the water lower than to 10 feet down; but the quality was bad, with indications of sewage-contamination.

2. BEXLEY HEATH.

Proc. Geol. Soc., vol. iii., no. 65, p. 151 (1839).

Gravel and sand [Blackheath, Woolwich, and Thanet Beds] 140 } 170 feet
Chalk ... ... 30 }

3. BEXLEY HEATH. Brampton Place.

Communicated by Mr. W. MORRIS, from information given by Mr. VENNER of Bexley.

Steined, to Chalk [? to firm chalk] 129 } 159½ feet.
Chalk ... ... 30½ }

Headings driven, to get chalk, at about 140 feet down.

4. BEXLEY HEATH, near the Lord Bexley's Arms.

Dr. JAMES MITCHELL'S MSS., vol. iv., p. 261.

		Thickness.	Depth.
		Ft.	Ft.
Gravel [Blackheath Beds]		60	60
[Woolwich Beds]	Loamy sand	7	67
	Loose blowing sand, white, dry	15	82
	Stiff clay	8	90
Coarse [Thanet] sand		45	135
Chalk		18	153

5. BEXLEY HEATH. Mr. Shelwin's, near the Lion.

Dr. J. MITCHELL'S MSS., vol. iv., p. 262.

		Thickness.	Depth.
		Ft.	Ft.
Gravel [Blackheath Beds] ...		35	35
[Woolwich Beds]	Blowing sand	10	45
	Blue sand ...	16	61
Stiff sandy loam [Thanet] ...		54	115
Chalk		25	140

6. BEXLEY HEATH. Long Lane.

Proc. Geol. Soc., vol. iii., no. 65, p. 151 (1839).

To Chalk 124 } 214 feet
In ,, 90 }

7. LAMORBEY HOUSE (Mr. D. Scott's), 1874.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Bored throughout. Water-level 17 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Top ground and gravel [Blackheath Beds]... ...		25	25
[Woolwich Beds, 26 feet]	Shells	13	38
	Brown clay, with veins of blue	13	51
[Thanet Sand (? part Woolwich Beds), 65 feet]	Live sand, with a quantity of water	43	94
	Dead sand	22	116
Chalk		30	146

8. Near the Railway-cutting, W. of the village, to supply a temporary Brickfield.

Sunk and communicated by Messrs. DOCWRA.
Shaft 65 feet, the rest bored. Water-level 60 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Mould		1	1
Brick-earth [wash of London Clay]		5	6
[Oldhaven] Sand with red veins...		12	18
[Woolwich Beds]	Shells and blue clay ...	15	33
	Blue clay [? sands also] ...	33	66
[Thanet Sand, 63¼ feet]	Blue clay [?] and red sand	60	126
	Pebbles [? flints]	½	126½
	Green sand	2	128½
	Flints	¾	129¼
Chalk		45¾	175

9. Sidcup New Homes, Halfway Street, about 900 yards from Sidcup Railway Station. 1903?

Communicated by Mr. T. Dinwiddy (to Mr. T. V. Holmes).

		Thickness.	Depth.
		Ft.	Ft.
[? Oldhaven Beds]	Ballast	5	5
	Loam and sand ...	4¾	9¾
	Soft shells	2½	12¼
	Ballast and sand ...	2	14¼
	Hard shells	¾	15
	Clay and ballast ...	1½	16½
	Sand and clay... ...	5	21½
[Woolwich Beds, 34½ feet]	Shells and blue clay ...	2½	24
	Hard shells	2½	26½
	Shells and clay ...	2	28½
	Hard clay and shells...	3	31⅓
	Small shells	3½	35
	Black clay	1½	36
	Coloured [mottled] clay	3	39
	Hard sand	2	41½
	Grey sand and pebbles	3½	45
	Green sand	11	56
Live [Thanet] sand		72	128
Chalk		122	250

10. Wansunt Pumping Station of the Metropolitan Water Board. About half a mile from Crayford.

From the Engineer's Report (W. Morris) furnished by the Kent Water Co. to the Water Board Arbitrators, 1903.

32¼ feet above Ordnance Datum (the larger well), the other apparently a little higher.

1. Small shaft about 16 feet, then a large boring, lined to 78¼ feet down.

Loam ... ... about 11 }
[Upper Chalk] { Soft chalk ...over 14 } 253 feet.
{ Hard chalk, about 228 }

2. Large shaft 18 feet. Cylinders 34 feet deeper and rising over 8 feet in the shaft.

Section as above, but about 18 inches less loam.

Before the well was finished a supply of 2,000,000 gallons a day was got.

Birchington. Waterworks, *see* **Westgate.**

Blackheath. Shooter's Hill Road. Next house to the Sun in Sands (No. 123).

Communicated by Mr. C. Haworth, of Eltham.

		Thickness.	Depth.
		Ft.	Ft.
[Blackheath, Woolwich, and Thanet Beds]	Gravel [? and sand, at bottom]	104	104
	White sand	5	109
Chalk		30	139

Blean Hill, westward of Canterbury.

Ordn. Map 274, new ser.; Geol. Map 3.
PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x., p. 406.
To Chalk 160 feet.

Bobbing.

Ordn. Map 272; Geol. Map 3.

KEYCOLL HILL, Sittingbourne Waterworks, 1871.

About 204 feet above Ordnance Datum.

Communicated by Mr. W. L. GRANT, Surveyor to the Local Board. (*S.E. Naturalist*, 1902.) The thicknesses in brackets were given by Mr. R. D. BATCHELOR, whose account goes only to the depth of 398 feet.

Shaft 160 feet, the rest bored. Headings (about 90 feet, N.E. and S.W.) at 153 feet. Water comes at the end of these. The old and new wells are connected by a gallery. Water-level about 122 feet down when not pumping. About 330,000 gallons a day pumped. In Dr. SWEETING'S Report (to the Local Government Board) on the Milton Registration District, 1901, p. 16, it is said that "on an average only 19,000 gallons an hour can be pumped."

		Thickness.	Depth.
		Ft.	Ft.
Light-coloured sandy gravel ... ... (5) about		4	4
[(? Oldhaven) Woolwich and Thanet Beds]	Red and yellowish sand (15) ,,	16	20
	White sand	10	30
	Red sand	30	60
	Dark sand, with water (56½) nearly	57	117
	Large flints ... ... (3½) over	3	120
Chalk, 360 feet	White chalk	170	290
	Hard yellow chalk ... ... about	24	314
	Soft white chalk ... (4¼) ,,	4	318
	Hard white chalk ... ... ,,	6	324
	Soft white chalk ... (13¾) ,,	14	338
	Grey chalk. Yielded 125 gallons a minute 356 feet down ... about	32	370
	Hard blue chalk ... (4¾) ,,	4	374
	Soft white chalk ... (23) ,,	6	380
	Hard white chalk ... ... over	2	382
	Soft chalk ... ...nearly	4	386
	Gault clay [marl-bed] ... about	4	390
	White chalk. Yielded 150 gallons a minute	90	480

The Sittingbourne Works also partly supply the following parishes: Newington, Halstow, Borden, Murston, Upchurch, Hartlip, and Rainham.

Borstal, *see* **Rochester.**

Boston Heath, *see* **Plumstead.**

Boughton. Waterworks, 1896.

Communicated by Messrs. STEVENSON and BURSTAL. (*S.E. Naturalist*, 1902.)
About 70 feet above Ordnance Datum.

Shaft, with adits, 58 feet long by 6 by 3. Water stands 38 feet down.

Gravel 45 }
Chalk 55 } 100 feet.

According to Dr. F. PARSONS the yield at the Boughton-under-Blean works is 64,800 gallons in 24 hours.

Boughton Hill.

Ordn. Map 289, new ser.; Geol. Map 3.

MS. Geol. Soc.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[London Clay, 101½ feet]	Blue clay	90	0	90	0
	Septaria...	1	6	91	6
	Blue clay	20	0	111	6
[Oldhaven Beds, 19½ feet]	Very white sand	10	0	121	6
	Ferruginous sandstone ...	4	6	126	0
	„ „ denser	5	0	131	0
[Woolwich Beds, 27½ feet]	Reddish sand	10	0	141	0
	Coarse sand	9	6	150	6
	Fuller's earth	0	1	150	7
	Blackish sand	8	0	158	7

The total is given as 200 feet 1 inch.

Boxley.

Ordn. Map 288, new ser.; Geol. Map 6.

1. Boxley Grange, 1885.

? 565 feet above Ordnance Datum.

Bored and communicated by Mr. R. D. Batchelor, of Chatham; and from information and specimens from Messrs. Dunlop & Co. (*Quart. Journ. Geol. Soc.*, vol. xlii., p. 34).

		Thickness.	Depth.
		Ft.	Ft.
Chalk	Old well	—	348
	Hard chalk, with flint, and alternate layers of soft chalk, without water	258	606
Chalk Marl, and Gault (a fine blue clay, hard and dry). Specimen, from 879 feet, deep-green sandy clay, with pyrites		310	916
[Gault]	Dead green sand	2	918
	Light-brown clay	3	921
	Darker clay, specimen grey; also some crystals of pyrites at 922 feet	4	925
[Lower Greensand, or, in part, base of Gault]	Dead green sand	1	926
	Dead green sand with pyrites ...	2	928
	Dead green sand	4	932
	Rock	½	932½
	Dead green sand	5¾	938¼
	Rock	¼	938½
	Waterworn light-coloured sand ...	4	943
	Specimen of light-green sand at ...	—	953

A note of Mr. Topley's makes a well at Boxley 640 feet in Chalk and 320 in Gault to Sand (? a different version of the above).

2. Forstal, for MAIDSTONE WATERWORKS CO., 1898. Trial-boring. Close to the Medway, about half a mile above Aylesford.

Communicated by Mr. W. WARE, Engineer to the Company. (*Rochester Naturalist*, 1901.) (Notes from specimens in these brackets.)

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Gravel	... ...	19	0	19	0
[Folkestone Beds, 129¼ feet]	Yellow sand (Brownish sand at 20. Light-brown sand at 25, 35 and 45, the middle one duller, the lowest lighter, all loose. Clayey dull light-brown sand at 51)	32	0	51	0
	Brown clay (very fine compact clayey sand)	1	0	52	0
	Grey sand (Rather fine loose sand at 55. Dull dark-greenish, slightly clayey compact sand at 67) ...	15	0	67	0
	Green sand and clay. (Dull grey compact sand, ? slightly clayey, at 80 and 90, the latter darker) ...	25	0	92	0
	Green sand. (Brownish-grey sand, partly rather compact, but breaking up readily at 100, 110, 120; and at 130 the like, grey. At 140 fine green-grey sand, in part slightly compacted, but breaking up readily; some Glauconite grains)	55	0	147	0
	Rock. (Concretion of pyrites, a set of small balls, with wood, at 147¼)	1	3	148	3
[? Sandgate Beds]	Black clay. (Very dark greyish clay sand or sandy clay at 150)	7	0	155	3
Hythe Beds, 71 feet]	Rock (chert at 156½)	2	6	157	9
	Hassock. (Compacted, ? calcareous sand or soft stone, and stone, full of Glauconite grains at 157¾) ...	1	0	158	9
	Rock	11	0	169	9
	Hassock	1	6	171	3
	Rock	5	9	177	0
	Rock and Hassock	35	0	212	0
	Blue clay	4	0	216	0
	Rock	1	2	217	2
	Clay	1	0	218	2
	Hard sand	2	0	220	2
	Clay	2	0	222	2
	Rock	0	10	223	0
	Sand	2	0	225	0
	Rock	1	3	226	3
Atherfield Clay]	Sandy blue clay	8	6	234	9

This section shows that the Lower Greensand is thicker than was estimated by Mr. TOPLEY in "The Geology of the Weald" (1875), pl. iii., and this is wholly-owing to excess in the Folkestone Beds, the other two divisions being under the estimate (which is general for the Maidstone district, and not for this particular place). It must be noted that we have not the whole thickness of the Folkestone Beds here, the Gault not coming on above for some little distance northward. To the 129 feet of the section we must add not only the 19 feet taken up by Gravel, but something more, making the total thickness of the Folkestone Beds, say, 160 feet, if the classification suggested in the section is right.

Well, made and communicated by Messrs. Doowra.

In this cylinders were carried down to 141¼ feet. The section is as follows. A large supply has been got.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
[River Gravel] Ballast, as in the above	19	0	19	0
Hard yellow sand...	28	0	47	0
Hard sandy clay ...	3	6	50	6
Grey sand-rock ...	14	6	65	0
Green rock-sand and rock	9	0	74	0
Green sandy clay...	4	7	78	7
Green sand-rock and shells	3	0	81	7
Green sandy clay...	8	11	90	6
Shingle and rock...	0	6	91	0
Green sandy clay...	1	3	92	3
Sand-rock ...	3	0	95	3
Hard green sandy clay and beds of rock-sand	35	9	131	0
Hard rock and sand	3	0	134	0
Green sandy clay...	8	3	142	3
Hard grey sandy rock ...	2	0	144	3
Black clay...	7	0	151	3
Hassock and rock	73	9	225	0
Weald [Atherfield] clay...	37	0	262	0

(Total given as 261.)

3. Friend's Wood (not so called on the old Ordnance Map), over half a mile N.N.E. of Boxley Grange, for the water-supply of Maidstone.

Communicated by Mr. S. C. Homersham.

Height of the top of the well above Trinity high-water-mark 382 feet error]. A shaft sunk 386½ feet, and then 213½ feet bored [? more].

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Clay-with-flints ...		3	0	3	0
[Chalk, chiefly soft, with flints], 203¾ feet	Soft chalk, 13 beds of flints (6 to 12 inches thick)	52	1	55	1
	Hard chalk ...	1	8	56	9
	Soft chalk, 7 beds of flints (3 to 6 inches thick)	17	4	74	1
	Hard chalk ...	3	7	77	8
	Soft chalk, 2 beds of flints, and some scattered flints	10	11	88	7
	Hard chalk, a bed of flints ...	5	9	94	4
	Soft chalk, 2 beds of flints ...	5	8	100	0
	Hard chalk ...	3	0	103	0
	Soft chalk, 5 beds of flints (3 to 12 inches thick)	28	11	131	11
	Hard chalk ...	2	0	133	11
	Soft chalk, a bed of flints (damp places 3 and 42¼ feet down)	72	10	206	9

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Chalk, chiefly hard, without flints], 170 feet	Jointed chalk, the "joints" [divisions of the beds ?] chiefly horizontal ?	10	0	216	9
	Soft chalk (damp place 5 feet from base)...	30	0	246	9
	Hard chalk	4	0	250	9
	Soft chalk	6	0	256	9
	Hard chalk (damp place 10 feet from base)...	77	0	333	9
	Very hard chalk; "bull's head" ...	23	0	356	9
	Very hard chalk, "bull's head," darker	6	0	362	9
	Soapy bed [marly layer ?]	0	6	363	3
	Hard chalk	13	6	376	9
Grey Chalk.	Hard grey chalk	148	0	524	9
Chalk Marl, 70 feet	Light-coloured chalk-marl	42	0	566	9
	Dark chalk-marl	28	0	594	9
Gault.	Stiff blue clay...	8	6	603	3

[Where the flints divide beds of soft and hard chalk they have been classed with the former. Only in one case was a bed of flints found in hard chalk. The Upper Greensand seems to be absent.]

Branbridge.

Dr. F. PARSONS writes that the South Kent Water Co. made small works here. The well struck a bed of ironstone, and the water is ferruginous. It was used for the supply of Paddock Wood, but that place is now served with water taken from the Mid Kent Co.

Brasted. THE PHILLIPINES. Two borings, 1904.

Ordn. Map 287, new ser.; Geol. Map 6.

Made and communicated by Messrs. ISLER & Co.

1. Failed to get a supply.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Peat	1	1
	Loamy sand	1	2
[River Gravel]	Ballast...	23	25
[Folkestone Beds]	Loamy sand ...	55	80
[Hythe Beds]	Sandstone	4	84
	Kent rag	53	137
Atherfield Clay ...	... ...	23	160

2. A few hundred yards, in a westerly direction from 1.

Lined with 135 feet of tubes, of 6 inches diameter, up to the surface.

Water-level 99 feet down. Supply 500 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well		—	6
[Folkestone Beds, 21 feet]	Loamy sand and stone	12	18
	Rock	2	20
	Sand and sandstone ...	7	27
[Sandgate Beds]	Loamy sand	4	31
[Hythe Beds, 96 feet]	Kent rag	79	110
	Hassock	10	120
	Kent rag	7	127
[Atherfield Clay]	Atherfield clay ...	3	130
	Weald clay	8	138

Brenchley. Mr. Marchant's, Gedges, Matfield.

Ordn. Map 287, new ser.; Geol. Map 6.

Made and communicated (1901) by Messrs. Isler & Co.

Dug 6 feet, the rest bored. 240 feet of tubes, of 4 inches diameter, 3½ feet down.

Water-level 221 feet down. Yield 240 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Tunbridge Wells Sand]	Clay and rock ...	11	11
	Yellow clay ...	14	25
	Sand-rock ...	24	49
[Wadhurst Clay, 195 feet]	Blue clay	38½	87½
	Sand-rock ...	1½	89
	Blue clay... ...	155	244
[Ashdown Beds, 56 feet]	White sand-rock	2¾	246¾
	Clay and rock ...	2¾	249½
	Sand-rock ...	24	273½
	Clay and rock ...	1½	275
	White clay ...	1½	276½
	Clay and rock ...	1¼	277¾
	White clay ...	13¾	291½
	Clay and rock ...	6½	298
	Sand-rock ...	2	300

Broadstairs. Waterworks. Three Wells in Chalk, 1859.

Ordn. Map 274, new ser.; Geol. Map 3.

1. Richardson's Pumping Station, at the eastern side of the railway, by the bridge over, just westward of Wrotham House. Water unfit for drinking-purposes, and used only for street-watering, etc. About 600,000 gallons a month pumped in summer.

2. Crampton Pumping Station, on the western side of the railway, just south of the station. Water contaminated by admixture of sea-water. Yield 70,000 to 80,000 gallons a day. Mixed with the water from No. 3.

3. Rumfields Pumping Station. Nearly half a mile south-southwestward of St. Peter's Church. Adit driven to the boundary of the district (to the railway, west-south-west of Westwood Lodge, but not in a straight line; nearly a mile in all).

Present supply (1906, 1907), 245,000 gallons a day. Water good. St. Peter's, Reading Street, Northdown, Westwood, Northwood and Dumpton also supplied. An arrangement has been made with the Corporation of Margate to take a supply from their works at Wingham.

Brockley, *see* **Lewisham.**

Bromley.

Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4, (new.)

1. GASWORKS, just north of the London Chatham and Dover Railway, between Bromley and Bickley Stations. 1863.

Communicated by the MANAGER from memory.
About 172 feet above Ordnance Datum.
Shaft 50 feet, the rest bored. Plenty of water.

According to Mr. J. LUCAS (*Journ. Soc. Arts*, vol. xxv., p. 608), the total depth is but 115 feet, and the water rose to 42 feet below the ground.

		Thickness.	Depth.
		Ft.	Ft.
Mixed soil		50	50
[? Blackheath and Woolwich Beds]	Brick-earth and loam		
	Hard, rocky gravel and oyster-rock, 2 feet	90	140
	Pea-gravel and other gravel ...		
Green [Thanet] sand		10	150
Chalk		20	170

2. WIDMORE KILN. 1869?

Communicated by Mr. COLES CHILD.
About 190 feet above Ordnance Datum. Shaft 52 feet, the rest bored.

		Thickness.	Depth.
		Ft.	Ft.
From the surface of the ground to the top of the well ... ... about		—	20
[Blackheath Beds, ? 60 feet]	Mild earth with sand ... ,,	20	40
	Mild earth with sand veins ... ,,	10	50
	"Burley" and mild earth ... ,,	20	70
	Gravel (spring) ... ... ,,	10	80
[Thanet Sand, 60 feet]	Sand ... ... ,,	10	90
	Dirty earth: mild blackish clay ... ... ,,	10	100
	Sand, with about 2 feet of black earth at bottom ... ,,	40	140
Chalk ... ... ,,		10	150

Another well over 120 feet to chalk (? 32 feet in chalk).
25 feet from the surface of the ground to the top of the well.
Shaft 55 feet, the rest bored.
Water stands 6 feet below the top of the bore-pipe.

According to Mr. J. LUCAS (*Journ. Soc. Arts*, vol. xxv., p. 608), the water-level in one of these wells in 1877 was at 60 feet below ground before, and 75 after pumping; and the yield was 3,600 gallons an hour.

3. WIDMORE (Tylney Road), just east of the Kiln.

Communicated by Mr. COLES CHILD.

Dug 77 feet, the rest bored.

To Chalk 137 } 162 feet
In „ 25 }

4. PIXFIELD. 1817. Mr. Latter's house is near the bottom of the Ravensbourne Valley.

Communicated by Mr. R. B. LATTER to Sir J. Prestwich, 1856.

151½ feet above Trinity high-water-mark.

Ample supply of water from the Chalk. ? Rose to about 60 feet from the surface.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift? or Blackheath Beds ?]	Red clayey gravel	—	26
	Green clayey gravel	8 ?	34
	White clayey gravel...	7 ?	41
[Thanet Beds, 59 feet]	Marly sand	5 ?	56
	White porous sand	10 ?	61
	Marly sand, slightly clayey Marly sand ... ... Dark marly sand. Iron-stained flints at the base. Vein of water	44 ?	85
[Upper Chalk, 391 feet]	Chalk with many flints (white and soft)	269	354
	Chalk with interspersed flints, harder and yellow	78	432
	Chalk with few flints, soft and grey. The sides fell in a good deal ...	44	476
[? Middle Chalk]	Chalk without flints, hard	31	507
	Chalk, hard and yellowish	7 ?	514

There is some difficulty in making out the drawing. No thicknesses are given for the beds above the Chalk or for the lowest bed of the Chalk, and the surface is vague. It seems hardly likely that there should be so much as 41 feet of River Drift, and one would not expect the Blackheath Beds to rest on Thanet Sand here.

Brompton, *see* Chatham.

Brook. HOUSE about a quarter of a mile S. of W. of Church

Ordn. Map 289, new ser.; Geol. Map 3.

About 160 feet above Ordnance Datum.

Communicated by Mr. W. TERRILL, Surveyor to the Ashford Urban Council, 1899, from information from Mr. DAVIS, Builder.

A boring of 3 inches diameter, from which water overflowed.

Alluvial soil.

[Gault] Very hard blue clay, with fossils and metallic substances [? pyrites and phosphatic nodules] to 102 feet.

Water struck in green sand. Boring-tool dropped 2 feet, and would have dropped further if allowed.

Brookland. ROMNEY MARSH. 1847 or a little later ?

Ordn. Map 305, new ser.; Geol. Map 4.

Information from Mr. MACKESON to Sir J. Prestwich. 1872.

Believed that the Alluvium was not pierced at 60 feet. A small *Cardium* found at 40 feet.

The auger broke at a depth of about 90 feet, against a piece of rock (? Wealden).

Buekland. PAPER MILLS, close to the Dour.

Ordn. Map 290, new ser.; Geol. Map 3.

About 48 feet above Ordnance Datum.

According to Mr. H. E. STILGOE (1898) there are two borings, of 12 and 15 inches diameter, on either side of the river, from which 1,130 gallons a minute are continuously pumped from 4 a.m. on Monday to 2 p.m. on Saturday. Later information gives the quantity pumped from the former as 662,400 gallons a day, and from the latter 964,800.

Mr. H. HOBDAY, in the same year, said that the old well is about 100 feet deep and the new well 145. They are about 100 feet apart, and respectively 30 and 40 feet from the river. On Monday mornings the water rises to 3 feet down in the old well and to 9 feet down in the new well, which is 6 feet higher. In 1887 and 1888 the pumps were stopped for some time (owing to a fire), and then the water overflowed.

The water is from the Chalk.

Burham.

Ordn. Map 272, new ser.; Geol. Map 6.

1. BRICK LIME and CEMENT Co. 1897.

Made and communicated by Messrs. ISLER & Co. (*Rochester Naturalist*, 1901.)

Lined with 70 feet of tube, 18 inches in diameter, from 3 feet down and with 120 feet, of 15 inches diameter, perforated from a foot down.

Water-level, 5 feet down. Supply 9,000 gallons an hour.

Well 28 feet, the rest bored.

		Thickness.	Depth.
		Ft.	Ft.
Made ground	... ...	2	2
[Gault]	Gault clay	62	64
	Green sand	5½	69½
	Congealed pebbles [? phosphatic nodules]	2½	72
[Folkestone Beds]	Hard green sand	5¼	77¼
	Green loamy sand	¾	78
	Hard green sand	2½	80½
	Grey hard stone	1¼	81¾
	Soft green sand	8¼	90
	Hard light-coloured sand	9½	99½
	Soft dark blue sand	4	103½
	Hard dark blue sand...	1½	105
	Soft light-coloured sand	10	115
	Hard light-coloured sand	4	119

I am in doubt whether this section may not be just in Aylesford Parish instead of in Burham.

2. WEST KENT GAULT BRICK and PORTLAND CEMENT CO. A 16½ inch boring.

Made and communicated by Mr. R. D. BATCHELOR.

Water overflows and runs into the Medway, when the pumps are still about 10,000 gallons an hour. Tested to 30,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Alluvial [earth]		20	20
[Gault, 219 feet]	Clay	214	234
	Dead sand and nodules...	5	239
[Lower Greensand, 22¼ feet]	Dead green sand ...	1½	240½
	Hard rock	¾	241¼
	Dead sand	3	244¼
	Hard rock	1	245¼
	Very hard rock and sand	1	246¼
	Lower green sand ...	15	261¼

3. A note of Mr. W. TOPLEY's says that at the Margate Cement Works, more than a quarter of a mile north-westward of St. Mary's Church, a hole of 15 inches diameter has yielded 30,000 gallons an hour. The water overflows at the rate of 10,000 gallons an hour, and its level is lowered 8 or 10 feet by pumping.

Canterbury.

Ordn. Map 289, new ser.; Geol. Map 3.

1. DANE JOHN BREWERY (ASH & CO.), 1886.

From a local newspaper.

Bored throughout, 6 inches diameter, ending with 4 inches. Tubed to 190 feet.

Supply tested as follows:—At 250 feet, 288 gallons an hour; at 300 feet, 648 gallons; at 400 feet, 2,520 gallons.

	Thickness.	Depth.
	Ft.	Ft.
Made ground	14	14
Gravel ...	16	30
Chalk ...	370	400

2. LONDON CHATHAM AND DOVER RAILWAY STATION.

Communicated by Mr. R. D. BATCHELOR.

Shaft 30 feet; bore, of a foot diameter, 270; total, 300. Yield about 5,000 gallons an hour, as much as the pumps could raise.

3. ST. DUNSTAN'S (called St. Dunstan's Wood in Sir J. Prestwich's MSS.)

Dr. JAMES MITCHELL'S MSS., vol. iii., opp. p. 179. (*S.E. Naturalist*, 1902.).

	Thickness.	Depth.
	Ft.	Ft.
Vegetable mould	1	1
Sand	23	24
Blue clay, with a few shells	12	36
Blue clay, full of shells crushed together into one mass	6	42
Sand [? Oldhaven, Woolwich and Thanet Beds] ...	108	150

4. St. Dunstan's Brewery.

Boring made and communicated by Messrs. Isler.
Lined with 40 feet of tubes, of 8½ inches diameter, 20 feet down; and 70 feet, of 6 inches diameter, 18 feet down.
Water-level 25 feet down. Supply 3,600 gallons an hour.

Well (old) ...	32	250 feet.
Chalk and flints	218	

Second Well, 1898.

Lined with 100 feet of tubes, of 10 inches diameter, from 11 feet down; and with 150 feet, of 8½ inches diameter, from 4 feet down.
Water-level 20 feet down. Yield 10,000 gallons an hour.

Well (the rest bored)	9	252 feet.
[River Drift] Loam	6	
Chalk and flints ...	237	

5. The Monastery, near St. Thomas' Hill.

Sunk and communicated by Messrs. T. Docwra & Son.
Shaft (and iron cylinders) 150 feet, the rest bored.
Water-level about 105 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 49½ feet]	Yellow clay	28	28
	Blue clay	18	46
	[Sandy bed ? undescribed]	3½	49½
[Oldhaven and Woolwich Beds]	Sand, with a bed of pebbles (over a foot) about 10 feet down [? base of Oldhaven Beds], and a thin dark bed 7 feet from the bottom	44½	94
	Sandy clay	4	98
[Woolwich or Thanet ?]	Live sand	26	124
[Thanet Beds]	Green sand with clay	25	149
	[Blackish bed, undescribed]	3½	152½
	Green sand	55½	208
	[? Flints]	½	208½
Chalk, with four layers of flints in the top 12 feet		102	310½

6. St. Thomas' Hill Clergy Orphan Asylum, 1856.

Communicated by Mr. G. Dowker.
Water-level about 120 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Gravel		3	
[London Clay, 63 feet]	Yellow clay, with hard portions interspersed	9	12
	Blue clay, with septaria	47	59
	Imperfect claystone	7	66
[Oldhaven, Woolwich, and Thanet Beds]	Sand	74	140
	Bed with shells	5	145

Canterbury Waterworks, *see* **Thannington.**

Capel-le-Ferne. Folkestone Waterworks, on the eastern side of the road, a little N.E. of Lower Standen. 1898 ?

Ordn. Map 305, new ser ; Geol. Map 3.
Communicated by Mr. H. TURNER, Engineer to the Company.
Engine-room-floor 255 feet above Ordnance Datum.

Pilot-well, of 8½ feet diameter; permanent well elliptical, 14 by 9 feet; both 130½ feet deep. Adits driven from the pilot-well 352 feet N.W., 310 S.E., and 236, S.W. (6½ by 5 feet). The last connects the two wells.

The water has risen within 21½ feet of the engine-room-floor, in winter. At present (September 1907) it is 110 feet down at its highest and can only be lowered 25 feet by continuous pumping.

Yield at the time 900,000 gallons in 24 hours. It is intended to extend the adits.

Soil and flint 5 feet, the rest chalk.

Charing. MID KENT WATERWORKS.

Ordn. Map 288, new ser.; Geol. Map 3.

1. Just above the Pilgrim's Way, north of the town, 1901 (?). Originally made for the District Council.

Communicated by Mr. F. L. BALL (*S.E. Naturalist*, 1902).
Shaft 175 feet, the rest bored.

510 feet of tubes, of 8½ inches diameter, from 6 feet below the surface to the base of the Gault clay; then 102 feet, of 7½ inches diameter, from 495 feet down; the lowest 80 feet perforated.

Water-level 267 feet down. Yield 8,000 gallons an hour. Air-lift.

		Thickness.	Depth.
		Ft.	Ft.
[Middle and Lower Chalk]	Chalk	250	250
	Chalk marl, with 1½ inches of green sand at the base	82	332
[Gault, 191½ feet]	Gault clay	185	517
	Black rock	½	517½
	Green sand	5½	523
	Black rock	½	523½
[Folkestone Beds]	Green sand	7½	531
	Sandstone	15	546
	Green sand	52	598

2. Over ¾ mile S.W. of Church. Trial-boring 1905 (? 1904).

Made and communicated by Messrs. ISLER & Co.

		Thickness.	Depth.
		Ft.	Ft.
[Soil] Caller		1	1
[Gault]	Light-coloured clay ...	5	6
	Dark clay	6	12
	Green sand...	2½	14½
[Folkestone Beds]	Yellow sand	23½	38
	Sandstone	2	40
	Yellow sandstone	8	48
	Red stone [iron-sandstone]	2	50
	Yellow sand	54	104

Charlton.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new.)

Messrs. SIEMENS & Co.'s WORKS, on the Marsh, just W. of the former Woolwich Dockyard.

Communicated by Messrs. SIEMENS.

1 and 2, tube-wells, in Bowater Road, respectively about 170 and 230 feet from the western end of the works, and 8 feet above Ordnance Datum, proved 26½ and 37 feet of alluvial beds, and 17½ and 6 of gravel, above Chalk, the upper part soft.

3 to 5 are trial-borings, not for water (see pp. 252, 253).

6 and 7. Abyssinian Tube Wells, afterwards excavated down to gravel.
6 about 70 feet N. of Bowater Road, a little W. of the centre of the works.
7 Northern side of Bowater Road about 520 feet W. of Trinity Street.
9 and 8 feet above Ordnance Datum.

Chartham. KENT ASYLUM, 1874.

Ordn. Map 289, new ser.; Geol. Map 3.

From a tracing communicated by Mr. J. GILES (*Quart. Journ. Geol. Soc.*, vol. xlii., p. 35).

254 feet above the level of the Stour.

Shaft 261 feet, with two headings each 100 feet long, east and west, at 257 feet, the rest bored.

First water-level 231 feet down. Present water-level (? October, 1874). 238 feet down. ? Pumped down 10 feet.

About 80,000 gallons a day used.

		Thickness.	Depth.
		Ft.	Ft.
Upper Middle and Lower Chalk, about 734 feet.	White chalk with beds of flints ...	261	261
	Soft chalk with flints	51	312
	Black sticky chalk with flints ...	8	320
	White chalk with few flints... ...	53	373
	Hard rocky chalk with veins of pyrites	11	384
	Hard chalk with flints	16	400
	Light-coloured chalk with few flints	60	460
	Hard grey chalk with beds of stone	44	504
	Dark sticky chalk, hard in places [a specimen from a depth of 607 feet is clayey chalk, rather dark; another from 731 feet, is chalk marl, with green grains; and another, from 732 feet, is the same, with more green grains] ...	230	734
	Dark sand [base of Chalk Marl] ...	⅔	—
Gault clay [specimens grey and calcareous ?] ...		5⅓	740

Mr. G. DOWKER says: "From the specimens I have seen at the Canterbury Waterworks, I doubt if they quite reached the Gault." (*Geol. Mag.*, 1887, dec. iii., vol. iv., p. 208.)

Chatham.

Ordn. Map 272, new ser.; Geol. Map 6.

1. DOCKYARD.

Communicated by the Dockyard Authorities.
About 33½ feet above mean tide-level. No water.

	Thickness.	Depth.
	Ft.	Ft.
Dug through chalk (the rest bored) ...	40	40
Soft chalk with flints	9	49
Hard chalk with flints	10	59
Soft chalk with flints...	40	99
Hard chalk with flints	8	107
Soft chalk with flints...	40	147
Hard chalk with flints	8	155
Soft chalk with flints...	40	195
Hard chalk with flints	58½	253½
Hard and soft chalk	144¼	397¾
Hard chalk	40	437¾
Hard and soft chalk	20	457¾
Soft chalk	20	477¾
Hard chalk	20	497¾
Hard chalk with flints	20	517¾
Hard rock-chalk	20	537¾
Hard rock-chalk with iron-pyrites ...	40	577¾
Tough marl or gault, dark grey	48¼	626

[This last bed is most likely Chalk Marl.]

2. DOCKYARD EXTENSION. Well No. 1. 1868-1878.

E. A. BERNAYS.—Lectures on Chatham Dockyard Extension Works. Delivered at the School of Military Engineering, Chatham. For private circulation. Fol. *Chatham*, 1879. Pp. 13, 14. (*Quart. Journ. Geol. Soc.*, vol. xlii., pp. 28, 29.)

Measurements from the coping-level of the new basin, equals 5½ feet above high water of ordinary spring-tides.

Shaft and cylinders 67 feet, the rest bored.

At a depth of 301 feet an ample supply was found, but the water was very hard and of bad quality (from infiltration from the river); it was, therefore, shut out. Water rose from the bottom and overflowed; it was found that it would rise to 19 feet above the ground.

The flow was at the rate of 80 gallons a minute, which continued [for some time], the water being soft and good, with a temperature of 65 deg.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground and alluvial mud ...		12	0	12	0
[River Drift] Loamy gravel		10	6	22	6
[Thanet Beds ?] Loam		3	0	25	6
Chalk, 684½ feet	Soft chalk	22	0	47	6
	Hard chalk	552	0	599	6
	Chalk marl	110	6	710	0
[Gault 193½ feet]	Gault [clay]	191	6	901	6
	Rock [? nodules] ...	0	9	902	3
	Greenish sandy marl	0	6	902	9
	Rock [? nodules] ...	0	9	903	6
To [Lower] Greensand					

Information communicated by the Dockyard authorities differs somewhat in details (to the base of the Chalk), giving the following section. In the drawing from which part of this was taken the thickness of the beds was different on opposite sides, and the measurements were therefore made along a middle line. (*Quart. Journ. Geol. Soc.*, vol. xlii., p. 29.)

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
	Marsh-clay and mud	6	0	6	0
	River Gravel (? 9 to 12½ feet)...	11	3	17	3
	Loam [Thanet Beds]	3	9	21	0
Chalk, 689 feet	Chalk (soft rubble), with a layer of flints at bottom	43	1	64	1
	Block chalk, with many layers of flints	80	3	144	4
	Hard rocky material, called "white flint"...	2	9	147	1
	Chalk, with many layers of flints ...	139	1	286	2
	Hard chalk. Fissures 45 feet deep at about 300 feet, and a layer of black flint	234	10	521	0
	Chalk [a small specimen looked like ordinary Lower Chalk] ...	79	0	600	0
	Chalk Marl. At the bottom the following succession:—A soft bed, 2 feet thick, underlain by sandy loam, 1½ feet, and then hard Chalk Marl, 1 foot	110	0	710	0

In June, 1880, I saw at the Dockyard some of the cores that were brought up. The lowest 3 feet or so of the Chalk Marl was grey, with green grains, and with some small nodules (especially just above the base, which was given as 712 feet deep), differing slightly therefore from both versions of the section. The specimen showing the junction with the Gault was hardened; one part being Gault, the other Chalk.

3. DOCKYARD EXTENSION. Well, No. 2 (about 20 feet from No. 1). 1880-84.

From documents communicated by the Admiralty and from specimens. (*Quart. Journ. Geol. Soc.*, vol. xlii., pp. 29-31.)

Measurements taken from the level of the coping of the new basin, which is about 18 feet above Ordnance Datum.

Shaft 45 feet ?, the rest bored.

Water found August 17th, 1880, at a depth of 902 feet. After five hours it flowed over the pipe, 3 feet above the level of the coping.

At 912 feet the water contained about 1 per cent. of sand, of which several cart-loads were pumped up. The pump, 160 feet down, lifted 300,000 gallons in 24 hours, keeping down the water to 103 feet below the level of the coping.

		Thickness.	Depth.
		Ft.	Ft.
	Made ground ... ... about	15	15
	Loamy gravel ... ... [? Thanet Beds] Loam, with flints at the bottom	12	27
Chalk, 682 feet	Soft white chalk (Bullhead)...	9	36
	Hard white chalk, with beds of flint at intervals	116	152
	Grey chalk in layers, alternately hard and soft, with beds of flint at intervals. At a depth of 517 feet hard greenish chalk, 16 feet thick...	427	579
	Chalk Marl	130	709

			Thickness.	Depth.
			Ft.	Ft.
Gault, 193 feet		Clay (? more sandy at top). Specimens of grey clay from 870 and 890 feet deep ...	192	901
		Calcareous sandstone, with small black phosphatic nodules and many glauconite grains	1	902
Lower Greensand, 41 feet	Folkestone Beds, 30 feet	Sand. The beds fell in, so that their nature is a little uncertain. Specimen, from 912 feet (from water pumped up), fine sharp sand, with glauconite-grains...	11	913
		Coarse dark sand and grit, with nodules 6 feet down. Specimens, from 913 feet, phosphatized *Ammonites;* from 915 feet, with broken-up phosphatic nodules; from 918 feet, with waterworn phosphatic nodules. The nodules, MR. NEWTON thinks, may have fallen down from the Gault...	8	921
		Sandy beds with stones [nodules]. Specimens of fine sand, with glauconite-grains, from 921 and 924 feet, with nodules from 927 and 928½ feet	9	930
		Sandy beds, compact and dark. Specimens from 930 feet. Layer of nodules at the bottom	2	932
	Sandgate Beds?	Compact sandy clay, with nodules of impure iron-pyrites, 7 feet down. Specimens from 932 feet (with nodules), 934, 936, 940, 941, and 942 feet of grey clayey sand or sandy clay. At 939 feet a layer of nodules and pyrites	11	943
Oxford Clay.		Hard stiff clay, drying light-grey, with nodules [pyrites ?] 4 feet down (a specimen is of pyrites, partly crystalline, with an included piece of phosphatized *Ammonite*), and with a hardened layer 10½ feet down. Specimens from nearly every foot (wanting 944, 946, 948, 957, 959, 961-964), with pyrites from 943 feet; two phosphatic nodules [? fallen] from 953 feet	22?	965 ?

In a drawing the thickness of the bottom clay is made only 20½ feet, and the total depth 963½; but there is a specimen from 965 feet.

MR. E. T. NEWTON (who was sent to Chatham to see the specimens) reported that cores from the second boring (below 450 feet) were lying on the ground, but with no indication of the depths from which they came, although that was carefully marked when they were drawn. He added that a diary, kept in the office at the Dockyard, stated that the first core was drawn from a depth of 470 feet, though it seems that only a part, if any, of this first core had been preserved; so that probably the cores then lying on the ground began from below that depth, from which it follows that only about 240 feet of Lower Chalk was represented by them.

An examination of the cores showed, says MR. NEWTON, that at a depth of about 500 feet (30 feet from the top part) an irregular nodular bed occurs, with many shells of *Inoceramus* (which seemed to belong to *I. Brongniarti* and *I. Cuvieri*). He was unable to identify the zone of *Belemnites plenus*, though many *Belemnites* were said to have been found in the Chalk, but at what depth was not known.

Low down in the Chalk Marl the following characteristic fossils were got:—*Baculites baculoides*, a fragment of a Hamite, and part of a *Pecten Beaveri*.

The Gault cores were fast disappearing, broken up by frost and then overgrown, and no trace of fossils was to be seen. No clue could be got to any horizons therefore; but, from specimens sent to the Geological Survey in 1880, a list of 16 was made (*Quart. Journ. Geol. Soc.*, xlii., 31) and the fossils seem to have been chiefly found at depths of from 855 to 882 feet.

A small undeterminable Gasteropod was the only fossil found after washing specimens of the sandy clay forming the bottom part of the Lower Greensand, between the depths of 934 and 938 feet; whilst specimens from 941 and 942 feet yielded only fragments of shells. There is, therefore, no fossil evidence as to the age of the beds which have been classed as Lower Greensand, and it has been suggested that some few feet of the top part may be sandy beds of the Gault; but, in the absence of evidence, the only safe plan is to class the whole of these beds together.

Unless the few phosphatized *Ammonites* have fallen in from the junction-bed with the Gault, they are, I think, in favour of the above view, although the occurrence of derived fossils (as some of these seemed to be) has not been noticed in the Lower Greensand of this district. The specimens are much rolled.

A different version of a well at the Dockyard Extension was given in vol. iv. of the *Geol. Survey Memoirs*, p. 459, from a drawing. It was communicated (to Mr. C. E. Hawkins) by the Dockyard Authorities. The site is on the southern side of St. Mary's Creek.

About 10 feet above Ordnance Datum.
Iron cylinders about 70 feet, the rest bored.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Alluvium]	Marsh-clay and mud	6	0	6	0
[River Drift]	Gravel	11	3	17	3
[?Thanet Sand]	Loam	3	9	21	0
[Upper Chalk]	Chalk (soft rubble), with a layer of flints at the base	43	1	64	1
	Block chalk, with many layers of flints	80	3	144	4
	Hard rocky material known as white flint	2	9	147	1
	Chalk, with many layers of flints ...	139	1	286	2

Mr. **Hawkins** remarks that in the drawing the thickness of the beds was different on the two sides, the gravel, for instance, being 9 feet on one side and 13½ on the other. The above measurements were taken along a middle line.

4. Electric Light Works, Whittaker Street, No. 2 Well.

Made and communicated by Mr. R. D. **Batchelor**. (*Rochester Naturalist*, 1901.)

Shaft 21 feet, the rest a 14-inch boring. Water-level 20 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Surface soil		18	18
[Drift]	Chalk [? reconstructed]	6	24
	Gravel	1	25
	Gravel and chalk ...	7	32
[Upper Chalk]	Chalk	10	42
	Chalk and flints ...	127½	169½

According to the *Rochester and Chatham Times* of January 9th, 1892, the first boring, in Church Street (? made in 1891) yielded only 7,000 gallons an hour, whilst in the newer one (1892), "a phenomenal supply of 20,000 gallons an hour" was tapped from "sand strata below the chalk" [?].

5. BROMPTON, CHATHAM, GILLINGHAM and ROCHESTER WATERWORKS, Luton. 1856.

Communicated by Mr. S. M. SHECKFORD, Secretary to the Company.
(*Rochester Naturalist*, 1901).
Wells and headings.

According to Mr. E. EASTON the latter are at the depth of 130 feet, and there are several borings. There are many fissures in the Chalk. Water rises 75 feet. Yield believed to be considerably over 1,000,000 gallons a day.

Earth and flints, about	10	150 feet
Chalk, about	140	

Boring, 1902.

Communicated by Mr. W. C. FINCH, Engineer. (Notes in these brackets from specimens.)
In Well 152 feet deep.
92½ feet above Ordnance Datum.
Water rose to within 18 feet of the surface, and, at 68 feet down, the yield was 216,000 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
[Middle and Lower Chalk]	Chalk (at 219 feet hard [Melbourn Rock ?]; at 225 soft, friable, greyish [Belemnite Marl ?]; then whitish, but from 270 to 300 loose material only, ? filling up of fissure; at 304 not so whitish, but with tendency to grey)	340	340
[Lower Chalk]	Chalk Marl (at 345 grey, pale, and the like for some way down; at 435 darker grey, with iron-pyrites; similar to 445)	110	450
	Upper Greensand [basal part of Chalk] (at 450 sandy, with green grains, bits of mica and iron-pyrites)	2	452
[Chalk 3 feet, Gault 194 feet]	Gault (at 455 similar to above, but more clayey. A bigger specimen is distinctly from the bed with phosphate-nodules at the base of the Chalk; at 460 grey clay, with sand grains. Grey clay goes on, getting darker at about 530; *Belemnites minimus* at 615; bits of shells in places)	195½	647½
	Rock (a phosphatic nodule)... ...	1½	649
[Folkestone Beds, and Sandgate Beds 17½ feet.]	Lower Greensand (at 648½ [?] light-coloured sand with dark grains, on to 655) ... ... about	6	655
	Dead green sand (655 to 660 darker than the above; at 664 clay and green sand; then pale grey or brown-grey clay to the bottom? to clay, with bits of shells)	11½	666½

There is some doubt whether the clay at the bottom is part of the Lower Greensand or of some older bed.

Messrs. ISLER & Co., who made the boring, communicate some further particulars, as follows:—

Shaft 151 feet. Boring lined with 60 feet of tubes, of 20 inches diameter, 94 feet down; with 580 feet, of 18 inches diameter, 68 feet down; and with 40 feet, of 15½ inches diameter, perforated, 625 feet down.

They make the yield 25,000 or 30,000 gallons an hour, and their section differs a little in the upper part, thus:—

	Thickness.	Depth.
	Ft.	Ft.
Chalk	296	296
Chalk marl ...	141	437
Hard chalk marl	2	439
Chalk marl ...	12	451

6. CAPSTON PUMPING STATION of same Waterworks on the eastern side of the road, half-way between Hale and Capston.

154 feet above Ordnance Datum.

Well 245 feet, with gallery. Water found 138 feet down.

At a visit, in August, 1902, the shaft was seen to be bricked to about 90 feet (loose chalk, &c.) and the open part below showed no flints; a few, however, were seen in the short gallery, toward the road.

In a letter of January 18th, 1903, Mr. W. C. FINCH told me that soon after my visit a heading was begun in a southern direction, and, after driving only 77 feet, cut a large supply of water and the workmen were driven out.

The yearly supply of the whole works is 750 million gallons.

Chattenden *see* Frindsbury.

Cheriton? Messrs. EDMUNDSON'S ELECTRICITY WORKS, Shorncliffe, 1900 (?).

Ordn. Map 305, new ser.; Geol. Map 3 or 4.

Made and communicated by Messrs. ISLER & Co. (*S.E. Naturalist*, 1902.)

Lined with 110 feet of tubes, of 7½ inches diameter, and 63 feet, of 6 inches diameter, level with the surface.

Water-level 48 feet down. Supply 1,000 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Well (? the rest bored)		—		6	0
[Lower Greensand]	Dark red rock	2	0	8	0
	Dark green sand	2	0	10	0
	Green sand and rock mixed	4	6	14	6
	Brown sand and rock ...	4	6	19	0
	Green sand, rock and clay	5	0	24	0
	Green silver sand and rock	4	0	28	0
	Kentish rag...	4	5	32	5
	Green silver sand-rock ...	5	0	37	5
	Hard rock	8	0	45	5
	Green silver sand and rock	2	6	47	11
	Rock...	1	6	49	5
	Mixed sand...	1	0	50	5
	Hard rock sand	3	0	53	5
	Black sand	31	6	84	11
	Blue clay and sand ...	9	0	93	11
	Green sand...	27	6	121	5
	Blue sand and clay ...	21	6	142	11
	Blue clay	23	0	165	11
	Green sand clay	2	1	168	0

Chevening.

Ordn. Map 287, new ser.; Geol. Map 6.

1. "Near the BRICKYARD west of Froghall Farm the wells, on passing through 6 or 8 ft. of gravel, come upon a 'quicksand' which yields water. This appears from some samples turned out to be re-arranged Folkestone Beds," according to Mr. TOPLEY, in "The Geology of the Weald," p. 191. There is no name to the farm on the new Ordnance Map; it is about half a mile south-eastward of Chevening Cross. The brickyard is to the W.S.W.

2. CHEVENING PARK, close to the house.

Made and communicated by Messrs. ISLER & Co.

Water-level 58 feet down.

		Thickness.	Depth.
		Ft.	Ft.
	Well (? old, the rest bored)	—	63
[? All Gault]	Grey chalk [? chalky clay]	17	80
	Blue marl	9	89
	Dead green sand	3	92
	Sandy blue clay	7	99

3. MORANT'S COURT FARM.

J. LUCAS. *Trans. Inst. Surveyors*, 1877, vol. ix., p. 177.

About 352 feet above Ordnance Datum.

Depth nearly 94 feet. An Upper Greensand well.

Depth to water about 41½ feet, March 9th, 1876.

Chiddingstone.

Ordn. Map 287, new ser.; Geol. Map 6.

1. Locality doubtful. From Mr. CRAWFORD.

Water 350 to 400 feet from surface.

Weald Clay 300 to 350 feet [? sand beneath].

2. Mr. G. F. FAGE'S, 1884.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.

Water-level 44 feet down. Yield 6 gallons a minute.

	Thickness.	Depth.
	Ft.	Ft.
Dug well (the rest bored)	—	46
Blue clay	14	60
Blackish clay	10	70
Clay	31½	101½

? Two versions of one well.

Chiselhurst.

Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4 (new.)

1. On the Common near the Church.

Dr. James Mitchell's MSS., vol. iii, p. 178. (Libr. Geol. Soc. and Sir J. Prestwich's MSS.)

Water found at the bottom.

		Thickness.	Depth.
		Ft.	Ft.
Gravel [Blackheath Beds]		8	8
[Woolwich Beds]	Blue clay full of shells	12	20
	Rock full of shells ...	2	22
	Blue clay with shells	5	27
	Rock full of shells ...	1	28
	Blue clay and shells...	6	34
	Rock full of shells ...	1½	35½

2. Scadbury Park, E. of the village.

Made and communicated by Messrs. Isler & Co.

Well 12 feet, the rest bored. Lined with 110 feet of tubes, of 4 inches diameter (? from 4½ feet down.)

Water-level 153 feet down. Yield 400 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Lower London Tertiaries.]	Sand and clay...	12	12
	Clay	7	19
	Mottled clay ...	8	27
	Green sands ...	16½	43½
	Brown sands ...	57½	101
	Mixed sands ...	13	114
Chalk and flints		121	235

3. Susan's Wood. On the road to Bromley and about 80 feet lower than the Common.

Sir J. Prestwich's MSS. Old well.

		Thickness.	Depth.
		Ft.	Ft.
Gravel		7	7
[Woolwich Beds]	Blue clay full of shells ...	9	16
	Rock full of shells	3	19
[Thanet Sand]	Hard white sand	40	59
	Blue sand	6	65
	Iron-flint with ochreous clay	1	66
Chalk		20	86

4. Woodheath. 1902.

Made and communicated by Messrs. Docwra.

Water found at 20½ feet, where the shaft ends, the bottom being filled with screened gravel. Further depth proved by rod?

Water rises 15 inches an hour, equal to 5,236 gallons in 24 hours.

		Thickness.	Depth.
		Ft.	Ft.
Soil	...	2	2
[? Blackheath and Woolwich Beds]	Gravel ...	2	4
	Sand ...	8	12
	Sand and shells, ¼; black clay, ½; sand and shells, ¼; black clay, ¾; sand and shells, ¼ ...	2	14
	Grey sand, 2; shells, 1¼ ...	3¼	17¼
	Grey sand, 3; shells, ¼ ...	3¼	20½
	Black clay ...	9½	30

Chislet.

Ordn. Map 273, new ser.; Geol. Map 3.

Upstreet Post Office. Messrs. Newby Bros. Two wells.

Made and communicated by Messrs. Isler & Co.

No. 1. Lined with 120 feet of tubes, of 4 inches diameter, from a foot down. Water-level 60 feet down. Yield 2,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well (the rest bored) ...		—	20
[Oldhaven Beds]	Loamy sand ...	6	26
	Dead sand ...	8	34
	Black ballast [? flint-pebbles]	12	46
[Woolwich Beds]	Green sand ...	32	78
	Black sand ...	63	141

No. 2. Lined with 95 feet of tubes, of 4 inches diameter, level with the surface.

Water-level 66 feet down. Yield 2,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well (the rest bored) ...		—	6
[London Clay]	Clay and stones ...	8	14
	Clay ...	12	26
[Oldhaven Beds]	Sand ...	20	46
	Black ballast [? flint-pebbles]	10	56
[Woolwich Beds]	Green sand ...	38	94
	Black sand ...	11	105

Chitney Hill, *see* Iwade.

Cliffe.

Ordn. Map 272, new ser.; Geol. Map 1, S.E.

1. Fort.

Communicated by Col. E. M. Grain, R.E.

Bored throughout. ? Water-level nearly 6 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground	...	1	1
[Alluvium, 38 feet]	Mud ...	15	16
	Peat ...	1	17
	Mud ...	8	25
	Peat ...	3	28
	Mud ...	7	35
	Peat ...	4	39
[River Drift, 37 feet]	Loamy sand and gravel	6	45
	Loamy sand ...	6	51
	Hard gravel ...	7	58
	Sand ...	1	59
	Hard gravel ...	7	66
	Loamy sand and mud	10	76
Chalk	...	44	120

2. Messrs. Curtis & Harvey's Factory.

In the Marsh, 1½ miles W. of N. from Darnley (West Street), 1901, and nearly half a mile S.S.E. of Lower Hope Point.

·Made and communicated by Messrs. Le Grand and Sutcliff.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Blue clay ...	29½	29½
[? Alluvium]	Running sand...	18½	48
[River Drift]	Sand and ballast	35	83
[? Thanet Beds]	Sandy clay ...	27	110
[Upper]	Chalk and flints	271	381

Able to pump about 500 gallons an hour at a depth of about 200 feet. After passing that depth the Chalk proved waterless. After the boring was lined they could not pump a gallon a minute.

Water very salt. Boring lined with steel tubes to 370 feet and water drawn from the bottom by means of a suction-tube 376 feet long, passing through a plug, at the depth of 340 feet, to prevent upper water from reaching the lower supply; but the water showed no signs of improvement and is still unfit for use.

A letter from Messrs. Curtis & Harvey (1905) differs in making the sandy clay 26½ feet, the chalk 291½, and the total 401.

Deep boring 1907. Made and communicated by Messrs. Isler and Co.

Well, 6 feet square, 5 feet.

Boring lined with 140 feet of tubes, of 12 inches diameter from 3 ft. 1 in. down; 236½ ft. of 9 in. diameter from 2¾ put down; and 925 feet of 7¼ inches diameter, 7 in. down.

Water, from the bore-hole, rose to 3 feet above the ground when the rods were in. Lowered to 32 feet down when the rods were out.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Brown peat	¼	—
	Brown mottled clay	4¾	5
	Blue sandy clay	21	26
	Green sand	16½	42½
	Black bog	½	43
[River Gravel]	Thames or river ballast	34¼	77¼
[Upper Chalk]	Grey chalk and flints	33	110¼
	White chalk and flints	389¾	500
[? Middle and Lower Chalk]	Chalk rock	14	514
	Hard block chalk	138	652
	Hard grey chalk	81	733
[Gault]	Green sandy clay	26	759
	Hard blue gault, with stones and fossils	172	931
	Conglomerate and hard rock ...	2½	933½
	Gault with stones and fossils ...	7½	941
Lower Greensand		19	960

This gives the Chalk a thickness of 655¾ feet, which agrees with what is found westward, and is some 26 feet less than at and near Chatham. The thickness of the Gault is more than what has been found in the Chatham district. It is possible that the Chalk Marl may reach lower than appears from the above account or that the bottom part of what has been classed as Gault may belong to the Lower Greensand.

The boring has been carried deeper, reaching Silurian beds: *see* ADDENDA.

3. Messrs. FRANCIS & Co., Cement Works, E. of village.

Made and communicated by Messrs. ISLER & Co.

Lined with 5 feet of tube, of 8½ inches diameter, 24½ feet down.

Well (old, the rest bored)	30	60 feet
Chalk and flints	30	

4. Mr. REEVES. Shaft of 3½ feet diameter.

Bullhead ...	8	32½ feet
Chalk and flints	24½	

Cobham. SCALES HILL (for Mr. G. W. BOOTH), 1900.

Ordn. Map 271 or 272, new ser.; Geol. Map 6.

Made and communicated by Mr. R. D. BATCHELOR. (*Rochester Naturalist*, 1901.)

Shaft [? all] of 4 feet diameter. Water-level 219 feet down.

		Thickness.	Depth.
		Ft.	Ft.
	Brick earth ...	2½	2½
Thanet Sand	Sand	47½	50
	Stones [flints] ...	½	50½
[Upper Chalk]	Chalk	7½	58
	Chalk and flint	179	237
	Rock chalk ...	5	242
	Chalk and flint	5	247

Cowden. Messrs. BRACKETT'S. 1900.

Ordn. Map 303, new ser.; Geol. Map 6.
Made and communicated by Messrs. DUKE and OCKENDEN.
Water found at 49, 62, and 124 feet.

	Thickness.	Depth.
	Ft.	Ft.
Clay	8	8
Sandstone... ...	22	30
Clay and ironstone	9	39
Hard clay... ...	16	55
Sandstone... ...	5	60
Clay and ironstone	98	158

Cranbrook.

Ordn. Map 304, new ser.; Geol. Maps 6 and 5.

1. GRAMMAR SCHOOL, 25 yards east of road to Staplehurst, 70 yards south of road to Benenden. 1878.

This well is not used, but a supply is got from the Cranbrook Water Co.

Communicated by Mr. A. WILLIAMS.
Water stands 6 to 10 feet in the well, and is much polluted.

	Thickness.	Depth.
	Ft.	Ft.
Soil	5 to 6	6
[Upper Tunbridge Wells Sand] Rock	1	7
[Grinstead Clay] Mottled clay	3	10
[Lower Tunbridge Wells Sand] Layers of yellow clay and sand-rock	20	30
Wadhurst Clay] Blue marl	7	37

Mr. TOPLEY has noted that ten years earlier a well was sunk (with a bore of 20 feet) near the stream just east of the Grammar School, 25 feet below the level of the latter, with the following result:—

? Lower Tunbridge Wells Sand	8	58 feet.
Wadhurst Clay. Blue marl ...	50	

2. RAILWAY HOTEL, HARTLEY, south-west of the town, on the eastern side of the high road. 1895.

377 feet above Ordnance Datum.
Bored and communicated by Messrs. LE GRAND and SUTCLIFF.

Two feet of water in well, easily baled out, "weepage" from sandstone, stands at 227 feet in bore-hole (December 28th, 1894, when the depth was 272 feet).

Water-level 229½ feet down. Yield about 3 gallons a minute, when finished.

		Thickness.	Depth.
		Ft.	Ft.
[Wadhurst Clay and Ashdown Sand]	Shaft, lately made by a local sinker, but no particulars noted. Specimen of hard, light-coloured sandy clay or fine clayey sand, streaked (? with vegetable matter) at 185 feet	—	205

		Thickness.	Depth.
		Ft.	Ft.
[? Ashdown Sand]	Grey marl rock	13	218
	Sandstone (or septaria ?)	1	219
	Grey marl rock	19½	238½
	Sandy marl	5½	244
	Sandstone and layers of marl ...	3	247
	Sandstone	2	249
	Sandy marl rock	8	257
	Sticky marl	1½	258½
	Grey marl	22	280½
	Sandy marl	7½	288
	Red sand rock...	7½	295½
	Marl	½	296
	Sand rock	3	299
	Sandstone and marl, mixed... ...	9	308
	Sandstone	½	308½
	Marl	18½	327
	Red marl	4	331

3. SISSINGHURST GRANGE. 1895.

(Milkhouse Street on the old map.)
Communicated by Messrs. MERRYWEATHER.
Diameter of bore, 6 inches; reduced at 88 feet to 5-inch tube, which was subsequently removed.
Water-level 80 feet, after plugging at 92 feet; depth of water, 54 feet.

		Thickness.	Depth.
		Ft.	Ft.
Soil, loamy	... ...	10	10
[Tunbridge Wells Sand]	Sandstone	20	30
	Yellow clay	1	31
	Sandstone	1	32
[Wadhurst Clay]	Blue clay	1	33
	White marl	4	37
	Blue clay	2	39
	Red clay.	2	41
	Red and blue clay	8	49
	Red clay	2	51
	Light-blue clay	15	66
	Yellow clay, with pebbles	5	71
	White marl	4	75
	Black clay	5	80
	Black clay and lignite ...	4	84
	Black clay, with stones ...	2	86
	Soft black clay	2	88
	Blue clay	3	91
	Soft yellow sandstone ...	2	93
	Blue marly clay	1	94
	White marly clay	4	98
	Blue and white clay ...	4	102
	Light-brown clay	1	103
	Blue marly clay	7	110
	Brown marly clay	8	118

4. The Cranbrook District Water Co. has the following places in the area supplied:—Cranbrook, Benenden, Goudhurst, Hawkhurst, Rolveden, St. Michael's, Sissinghurst and Tenterden (Water Works Directory, 1907). *See* ADDENDA.

Crayford.

WATERWORKS of the METROPOLITAN WATER BOARD, Station Road.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new.)

Three wells in an old chalk-pit. 30 feet above Ordnance Datum.

From the Engineer's Report (W. MORRIS) furnished by the Kent Water Company to the Metropolitan Board Arbitrators, 1903.

No. 1. Shaft and cylinders 30 feet, 2 of which are above ground-level. Bored to 180. Water-level (not pumping) 26 feet below the surface of the ground.

No. 2. Shaft and cylinders 34 feet. Bored to 155. Water-level while pumping, September 5th, 1903, 27 feet down.

No. 3. Shaft and cylinders 46 feet. Bored to 150. Water-level while pumping, same date, 35 feet down.

All three in Chalk.

In "The Geology of London," &c., vol. ii., the normal water-level is given as 15 feet down, on Mr. MORRIS's authority.

Crossness *see* Erith.

Cuxton. LONDON AND MEDWAY CEMENT CO.

Ordn. Map 272, new ser.; Geol. Map 6.

Made and communicated by Mr. R D. BATCHELOR. (*Rochester Naturalist*, 1901.)

Shaft 23 feet, the rest bored, 28 inches diameter, to 75 feet, and then 18 inches to 194.

Yield 25,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Brick-earth	21	21
	Gravel and sand... ...	1	22
	Brick-earth	1	23
	Soft running brick-earth	3	26
	Very hard gravel ...	10	36
	Very hard conglomerate	5	41
	Large flints	1	42
Chalk	Chalk and flints... ...	3	45
	Chalk, very little water	82	127
	Hard white rock... ...	1	128
	Tough chalk, little water	40	168
	Hard chalk	22	190
	Soft white chalk... ...	4	194

Carried down to over 400 feet deep.

Darenth.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., 6, London and its Environs, and London District, Sheet 4 (new.)

1. WORKS of the METROPOLITAN WATER BOARD, half a mile north-westward of the village, 1903.

Engineer's Report (W. MORRIS) prepared for Metropolitan Water Board Arbitrators (1903), with some later information from the Board.

Notes on the borings (1901) from Messrs. ISLER & Co.

Well and borehole (No. 1) connected by a gallery close to the bottom of the well, the former 42 feet above Ordnance Datum. Brick shaft and cylinders to the depth of 74 feet.

Original water-level nearly 9 feet down. After continuous pumping, about 58 feet down, September 12th, 1903. Lower since. Rose to about the original level October 27th, 1906, after a rest of 20½ hours.

Made ground ...	5	100½ feet
Ballast [gravel]	15	
Chalk	80½	

An account of a boring at the site of the well gives further details, being as follows. Apparently it must have struck on a pipe of gravel in the Chalk; indeed, the whole of the gravel here is probably in a pipe and not a mappable mass:—

		Thickness.	Depth.
		Ft.	Ft.
[Soil and River Gravel]	Loam soil	5	5
	Black soil with loamy ballast ...	2	7
	Clean ballast and large flints ...	9	16
	Clean ballast, small flints and sand	7	23
[Upper Chalk]	Soft chalk	7	30
	Medium chalk...	3	33
	Hard chalk	5	38
	Very hard chalk	4	42

There are also two deep borings, in the Marsh.

No. 1, about 131 feet south-south-westward of the well, from centre to centre.

37½ feet above Ordnance Datum.

Begins with a shaft 12 feet deep. Lined with 90 feet of tubes, of 2 feet diameter, 10 feet down. Is now plugged.

Water-level 2 to 4 feet down. Yield 60,000 gallons an hour.

Peat	2	250 feet
Ballast [gravel]	17	
Chalk and flints	231	

No. 2, about 61 feet south-eastward of No. 1, from centre to centre, and not connected.

Lined with 12 feet of cylinders, of 6 feet diameter, level with the surface, and 80 feet of tubes, of 2 feet diameter, 10 feet down.

Water-level 2 feet down. Yield 40,000 gallons an hour.

Dug well [? peat and gravel]	12	250½ feet
Ballast [gravel]	4¾	
Ballast and chalk	1¼	
Chalk and flints	232½	

2. METROPOLITAN WATER BOARD, Green Street Green, about seven eighths of a mile S. of E. from the Church. 1902.

83 feet above Ordnance Datum.

Made and communicated by Messrs. ISLER & Co. (and Engineer's Report as above).

Shaft 32 feet, the rest bored. Lined with 50 feet of tubes, of 2 feet diameter, 30 feet down.

Water-level 31½ feet down. Yield 43,000 gallons an hour, after blasting, before which only 30,000 gallons an hour could be got.

Soil	2	250 feet
[River Gravel] Ballast...	12	
[Upper] Chalk and flints	236	

Mr. W. MORRIS adds that two dynamite-charges were fired 200 feet down, and that in testing by an air-lift, a supply at the rate of ¾ million gallons a day was got.

3. METROPOLITAN ASYLUMS BOARD. Darenth Wood. Imbecile School. 1876.

Communicated by Messrs. A. and C. HARSTON.
238 feet above Ordnance Datum. Shaft throughout.
Water-level 216 feet down ; reduced somewhat by subsequent sinking and pumping of wells near by.

		Thickness.	Depth.
		Ft.	Ft.
Earth (soil) and loam	... ...	4	4
[Upper Chalk]	Tough hardened chalk	1	5
	Rubble chalk, with boulder [? large] flints...	69	74
	Hard chalk, with layers of flints ...	142	216
	Soft chalk, with layers of flints ...	12	228
[? Middle Chalk]	Hard chalk	1½	229½
	Rock chalk, dense and impermeable	4	233½
	Hard chalk, without flints	12½	246

Darnett Ness, *see* **Gillingham.**

Dartford.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs and London District, Sheet 4 (new.)

1. BREWERY (MR. KIDD'S). 1896.

Made and communicated by Messrs. ISLER & Co.
Lined with 80 feet of tubes, 7¼ inches in diameter, from 5½ feet down.
Water-level 9½ feet down. Supply 7,200 gallons an hour.

[River] Gravel 56 } 250 feet
[Upper] Chalk 194 }

The thickness of Gravel seems too great. Perhaps some Made Ground, &c., is included.

2. DAILY TELEGRAPH PAPER MILLS.

Made and communicated by Messrs. ISLER & Co.
Lined with 60 feet of tubes, of 18 inches diameter, 3 feet down.
Water-level 10 feet down. Supply 30,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Peat	4	4
	Light-coloured clay and sand	4	8
[River Drift]	Light-coloured sand	2	10
	Ballast [gravel]	5	15
	Yellow clay	1	16
	Ballast [gravel]	24	40
Chalk and flints	... ...	260	300

3. DARTFORD FIBRE CO.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 8½ feet down.
Tube and boring, through ballast [gravel, &c., ? 50 feet] and Chalk, 75 feet

4. GASWORKS, 1900.

Made and communicated by Messrs. ISLER & Co.
60 feet of tubes, of 4 inches diameter, 4 feet down.
Water-level 10 feet down. Supply 2,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well (the rest bored)		—	5
[River Gravel]	Ballast	10	15
	Shingle	31	46
Chalk and flints ...		84	130

5. METROPOLITAN WATER BOARD. Overy Street, by the eastern side of the Darent 1900?

Made and communicated by Messrs. ISLER & Co.
Lined with 25 feet of iron cylinders, level with the surface, and with 82 feet of tubes, of 2 feet diameter, from 23 feet down.

Water-level 5½ feet down. Mr. MORRIS records that this level was reduced to only 10 feet down while pumping, July 18th, 1903. Yield 80,000 gallons an hour.

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
Made ground		2	6	2	6
[River Gravel]	Ballast	17	4	19	10
	Ballast and chalk, with chalk from 25¼ to 26 feet down	7	8	27	6
[Upper] Chalk and flints		225	3	252	9

6. Messrs. PIGOU & Co.'s GUNPOWDER MANUFACTORY.

Made and communicated by Messrs. ISLER & Co.
Lined with 35 feet of tubes, of 6 inches diameter, from 6 feet down.
Water-level 9½ feet down. Supply 1,680 gallons an hour.

Well, the rest bored	8	108 feet
[River] Gravel ...	20	
Chalk	80	

Another well, on the same authority, 1897:

Lined with 40 feet of tubes, of 7¼ inches diameter, from 11 feet down
Water-level 13½ feet down. Yield 10,800 gallons an hour, the water being lowered 6 feet.

Well (the rest bored).	Ballast and large flints	12	200 feet
[Upper Chalk]	Chalk	12	
	Chalk and flints	176	

7. Messrs. SAUNDERS, Paper Manufacturers, 1896.

Made and communicated by Messrs. ISLER & Co.
Lined with 35 feet of tubes, 7½ inches in diameter, from 1½ feet down.
Water-level 9 feet 10 inches down. Supply 8,700 gallons an hour.

[River] Gravel	22	100 feet
[Upper] Chalk	78	

8. DARTFORD CREEK. Paper Mills. For supply of engines.

Sunk and communicated by Messrs. DOCWRA & SON.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Gravel ...	13	13
	Coarse gravel	20	33
Chalk	Chalk ...	5	38
	Flints ...	2	40
	Hard chalk ...	43	83

9. DARTFORD CREEK. Paper-mills (? same), 1864.

Sunk and communicated by Messrs. DOCWRA & SON.
Shaft 10 feet, the rest bored. Water rose to within 2 feet of the surface.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Alluvium and Valley Gravel, 30 feet.]	Bog	6	0	6	0
	White pulpy sand	3	0	9	0
	White sand	1	0	10	0
	White gravel	2	0	12	0
	Marl	0	6	12	6
	White sand and flints	17	6	30	0
Chalk, 220½ feet.	Grey chalk	6	0	36	0
	White running sand	1	0	37	0
	Grey chalk with flints	23	1	60	1
	Hard grey chalk	19	9	79	10
	Good chalk with many scattered flints	73	0	152	10
	Chalk	49	9	202	7
	Firm white sand [sandy marl ?] ...	0	10	203	5
	Rotten chalk	7	0	210	5
	Good chalk	40	0	250	5

10. DARTFORD MARSHES. Metropolitan Asylums Board Landing, close to the Thames, half-way between Long Reach Tavern and Little Powder Creek. 1894.

Boring made and communicated by Messrs. ISLER & Co., with notes from Messrs. HARSTON.
Lined with 55 feet of tubes, of 7¼ inches diameter.
Grass-level 7 feet above Ordnance Datum.
Water to surface, but brackish.

		Thickness.	Depth.
		Ft.	Ft.
Alluvial mud		25	25
[River Drift]	Gravel	16	41
	Ballast	6	47
	Blowing sand (with 18 inches of flints at the base)	5	52
[Upper Chalk]	Grey chalk	17	69
	Grey chalk and flints	51	120

11. There is a well, said to be about 150 feet deep, at the London County Council's Heath Asylum (1897 ?), through gravel and sand to Chalk; but no information could be got from the Asylums Committee. The well supplies the Asylum.

Mr. A. **Harston**, however, tells me that at a cottage at the corner of the roads by the eastern end of the Asylum-grounds (and just in Wilmington parish ?) there is a well, 133 feet above Ordnance Datum, with the following section, probably to only 2 or 3 feet below the water-level:—

[River Drift]	Loam...	8	99 feet
	Gravel	25	
Chalk		66	

12. The London Paper Mills.

Made and communicated (1907) by Messrs. **Isler** & Co.
52 feet of tubes, of 18 inches diameter, about 5 feet down.
Supply 35,000 gallons an hour.

	Thickness.	Depth.
	Ft.	Ft.
Made ground	5	5
[River Drift] Sand and gravel	18	23
[River Drift] Thames gravel...	4	27
Chalk and flints	273¾	300¾

Deal.

Ordn. Map 290, new ser.; Geol. Map 3.

Mr. W. **Topley** has noted a boring here, with tubes of 1¼ inches diameter, in which brackish water was found at the depth of 18 feet, fresh water at 45 feet, and very salt water at 116 feet. The salt water was shut off and the good water used for a steam flour-mill and for domestic purposes. There was gravel and brick-earth over the Chalk.

Waterworks, *see* **Walmer.**

Deptford.

Ordn. Map 270, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new.)

1. Brewery (Lambert's).

F. **Braithwaite**. *Proc. Inst. Civ. Eng.*, vol. v., p. 203.

To Chalk	55	178 feet
In ,,	123	

2. Cattle Market (formerly Dockyard), 500 feet from the entrance-gates, in King Street, and 460 feet from the Thames.

Communicated by **Sir H. Jones**, Architect to the City of London.
Shaft 23¾ feet, the rest bored.
100 gallons a minute pumped = 72,000 a day of 12 hours.

At 22¾ feet deep in good gravel.
,, 24-25 ,, ,, running sand.
,, 25-50 ,, ,, very hard gravel.
,, 50-55 ,, ,, chalk.

A boring was made here by Messrs. **Tilley**, in 1894, to the depth of 662½ feet. Plenty of water was found between 100 and 200 feet down, but it was bad and was therefore shut out. At 300 feet blue clayey chalk, with occasional flints and bands of hard white chalk, was found, but with no water. At 600 feet the yield was about 6 gallons a minute, at 200 feet down. Mr. **Jukes-Browne** says that a specimen from the bottom is Chalk Marl, and probably low in that, as glauconite could be seen with a lens.

3. METROPOLITAN WATER BOARD WORKS, on either side of the Ravensbourne, above Deptford Bridge.

Engineer's Report (W. MORRIS) prepared for Metropolitan Water Board Arbitrators (1903).
Three wells in use, and others not used.

GARDEN WELL, at the southern end of the grounds. 19 feet above Ordnance Datum.

Shaft and cylinders about 95 feet, connected by a short heading with a boring of 250 feet.

Original water-level in the well, about 6 feet down.

Water-level when not pumping, August 24th, 1903, about 16 feet down.

Water-level while pumping, August 28th, 1903, about 58 feet down.

		Thickness.	Depth.
		Ft.	Ft.
	Made earth	4	4
[Alluvium]	Dark clay	3	7
	Peat	1½	8½
[River Drift]	Gravel	5	13½
	Sandy loam	6	19½
	Gravel	2	21½
	Sand	1	22½
[Upper Chalk]	Chalk marl and flints	10½	33
	Chalk	217	250

TWINS WELL, in the central part of the ground, 17½ feet above Ordnance Datum. Shaft and cylinders, 105 feet.

Original water-level, 5 feet down.

Water-level when not pumping, August 24th, 1903, 20 feet down.

Water-level while pumping, August 27th, 1903, 77 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Old Filter Bed	Sand ... Shingle ... Kentish rag Clay ...	8	8
[River Drift]	Coarse gravel ...	17	25
[Upper Chalk]	Loose rusty chalk	22	47
	Hard chalk ...	58	105

COLD BATH WELL. Really two wells, at the eastern end of the grounds, 19½ feet above Ordnance Datum. Old well. Shaft and cylinders 43 feet, boring to 300. Newer well, shaft and cylinders, 98 feet, connected by a heading with the boring.

Original water-level 5½ feet down.

Water-level when not pumping, August 24th, 1903, 15½ feet down.

Water-level while pumping, same date, 56 feet down.

		Thickness.	Depth.
		Ft.	Ft.
	Made earth	4	4
[Alluvium]	Alluvial deposit	2	6
	Peat	4½	10½
[River Drift]	Pebbly gravel and sand ...	5½	16
[Upper Chalk]	Chalk marl mixed with flints	3½	19½
	Soft chalk	15	34½
	Hard chalk	265½	300

Mr. MORRIS remarks that the wells have never been worked continuously; but once, in order to test the yield, the Garden and the Twins Wells were pumped continuously for four days and yielded 8,000,000 gallons a day.

4. **NAVAL SCHOOL.** Between the London and Brighton and the South Eastern Railways, S. of New Cross Road. 1844 ?

PRESTWICH. *Quart. Journ. Geol. Soc.*, vol. x., p. 105.
About 70 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
London Clay, 23 feet	Yellow clay...	10	10
	Blue clay	13	23
Woolwich Beds, 54 feet	Shells in sand	10	33
	Hard shells...	3	36
	Sand with water	1	37
	Sand with shells	15	52
	Shells and clay mixed ...	5	57
	Sand...	1	58
	Hard shells in sand ...	2	60
	[Bottom-bed] Pebbles ...	15	75
	[Bottom-bed] Green sand	2	77
Thanet Sand, 48 feet	Hard sand	14	91
	Sand...	34	125
Chalk ...	... ...	25 (or	more?)

An older note of this well gives the depth of the shaft as 50 feet, the bore 130 feet more, and the water-level within 60 feet of the surface.

According to Mr. J. LUCAS (*Journ. Soc. Arts*, vol. xxv., p. 608), the shaft is 75 feet, the total depth 185 feet, and the water-level, in April 1877, before pumping, was 72 feet down.

5. **STOWAGE WHARF.** East London Electric Supply Corporation 1901 ?

Made and communicated by Messrs. MERRYWEATHER.
Shaft 100 feet, the rest bored. Water-level 19 feet down.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground		8	0	8	0
[? Alluvium]	Blue clay	4	0	12	0
[? River Drift]	Gravel (water) ...	2	6	14	6
	Gravel and sand ...	9	6	24	0
[Woolwich and Reading Beds, 72 feet]	Shells and clay ...	2	0	26	0
	Mottled clay ...	4	0	30	0
	Green sand and clay	10	6	40	6
	Black [flint] pebbles	1	6	42	0
	Blue clay	1	0	43	0
	Grey sand	1	2	44	2
	Green sand and clay	1	10	46	0
Live fine [Thanet] sand		50	0	96	0
Chalk		324	0	420	0

6. **TRUNDLEY'S ROAD.**

Communicated by Dr. J. C. THRESH.
Superficial deposits 16 } 100 feet
Chalk ... ... 84 }

Height above Ordnance Datum.	7, 8, 9, 10, Various.	Feet to Chalk.
About 15 ?	Dockyard (BRAITHWAITE, *Proc. Inst. Civ. Eng.*, vol. ix., pl. 7)	90
„ 10 ?	Victualling-yard (MYLNE'S *Sections of the London Strata*)	60*
„ 20	Boring near the Kent Waterworks (communicated by Mr. BAMBER)	34
„ 18	Broadway. Public well, also from Mr. BAMBER	66

* "It is said that the Chalk . . . was found at the depth of 108 feet in sinking a well at the Victualling Office, Deptford."—Manning and Bray, History of Surrey," vol. iii., p. lxxviii. (1814.)

In *Water*, vol. vi., no. 63, p. 116, is a note of a well at St. Paul's Deptford, 250 feet deep, yielding 42,000 gallons an hour.

Detling or **Deptling**. House on western side of lane, ⅞ of a mile W. of S. from the Church.

Ordn. Map 288, new ser.; Geol. Map 6.
Information on the spot, March, 1898.
Gault. 55 feet of clay. ? Lower Greensand touched.

Dover.

Ordn. Map 290, new ser.; Geol. Map 3.

1. Castle.

340 feet above Ordnance Datum.
367 feet deep, with two adits 14 feet below Ordnance Datum.

One in a south-south-westerly direction, is 250 feet long and has ten springs; the other in a north-easterly direction, 170 feet long and not yielding water.

Rest-level of the water fairly constant and about 10 feet above Ordnance Datum. Yield 36,000 gallons a day.

2. Convict Prison, East Cliff. 1885.

Made and communicated by Mr. R. D. Batchelor, and from specimens from him. Also from information and specimens from the Home Office. (*Quart. Journ. Geol. Soc.*, vol. xlii., pp. 35, 36; vol. xliii., pp. 201, 202.)

280 feet above the level of the sea.
Shaft 315 feet, with headings at the bottom; the rest bored.
Water found at 315 feet, in headings, to the extent of 18,000 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
Soil ...	... ...	1	1
[Chalk, 674 feet]	Upper Chalk, with flints	249	250
	Middle Chalk, few flints	145	395
	Rocky yellow chalk, no flints ...	39	434
	Chalk Marl [=clayey chalk]	14	448
	Lower or grey Chalk (specimen of clayey chalk at 630)	182	630
	Upper Gault or Chalk Marl [the latter]	42	672
	Upper Greensand [=green base of Chalk Marl], without water ...	3	675
Gault, 143 feet.	Gault. Specimens, grey sandy clay at 721; grey sandy clay with green grains at 800 (both calcareous); light-greenish sandy clay or clayey sand at 813; phosphatic nodules, depth not marked. At the site there was plenty of the ordinary dark grey clay, sometimes with green grains, and phosphatic nodules	138	813
	Rocky dead green sand	1	814
	Dead green sand	2	816
	Hard boulder-rock (? nodules) ...	2	818

		Thickness.	Depth.
		Ft.	Ft.
Lower Greensand. The lower part (and probably the whole) Sandgate Beds.	Dead green sand. Specimens, green clayey sand at 822; very fine-grained greenish clayey sand at 826; fine greenish-grey clayey sand, or sandy clay, at 831; a set of fine-grained grey or brownish-grey sandy clays or clayey sands, at 838, 840, 841, 844, 845, 847, and 848, compact and *exactly like the specimens from the Chatham boring* (932 to 943 feet)	31	849
? Wealden. Probably Hastings Beds, 82 feet.	Black sand and clay. Specimens, brownish-grey clay, rather sandy, at 856 and 858; brownish and grey clay at 862	13	862
	Brown clay. Specimens, brownish-grey, rather sandy clay at 864; grey and brown clay, with specks of pale very fine sand; brown and brownish-grey clay at 875; grey clay, with pale very fine sandy specks (*not* chalky, as was thought from the small specimen first seen)	17	879
	Dark sand and clay. Specimens, brown and grey clay, one slightly sandy, the other with pale specks (as above)	1½	880½
	Rock. All broken up, no specimen got	½	881
	Light-brown clay. Specimens, brown and grey clay at 882; brown clay at 884; grey clay at 885; grey and brown clay at 886; brown clay, and grey clay with specks of pale fine sand, at 888; grey clay at 890 (rather sandy) and 893	13	894
	Dark clay with pyrites. Specimens, grey clay at 895 and 898... ...	4	898
	Hard dark clay. Specimens, grey clay at 899, 900, 901, and 933, some with pale sandy specks ...	7	905
	Brown clay. Specimens, grey clay at 906; pale grey pipe-clay, with pale very fine-grained sandy lumps, the whole whitish and calcareous in appearance, but not so really	6	911
	Dark clay, with rag-boulders. (? Some error here, specimen at 913 being of whitish earth, like the last). Specimens, grey clay, with light-coloured patches, at 915; grey clay at 917 (one piece sandy) and 918	14	925
	Very light-coloured clay	5	930
	Darker clay. A small specimen, marked 937 (? should be 927), is light-grey rather sandy clay ...	1	931

Mr. JUKES-BROWNE has suggested that the rocky yellow chalk (395-434) may be Melbourn Rock (but this seems rather low for it); that the Middle Chalk may be 245 feet thick: that the beds from 434 to 630 (196 feet) are Lower Chalk; that the 42 feet next below are Upper Gault (but this makes the Gault very much thicker than at the outcrop, where it is about 100 feet thick, at Folkestone); and that the so-called Upper Greensand is a bed in the Upper Gault (as at Folkestone). I prefer the above classification.

Compare the section of the shaft for coal near Dover (p. 227.)

3. PRIORY RAILWAY STATION.

About 32 feet above Ordnance Datum. 39 feet deep.

Rest-level of water about 14¼ feet above Ordnance Datum. Yield 167,000 gallons a day.

4. WATERWORKS, Castle Hill. 1855.

Information from Mr. H. E. STILGOE, formerly Borough Engineer.
Engine-room floor 211 feet above Ordnance Datum.

Three wells, close together (two made in 1855, the third in 1882), 220½ feet in the Chalk, connected at the bottom by adits and supplied by long adits, about 7 feet high and 4 feet wide.

Rest-level of the water about 6 feet 8 inches above high water of ordinary spring-tides, or 17 feet above Ordnance Datum. When pumping is begun in the morning, after the water has risen to normal rest-level during the night, the water in the shaft is soon lowered and the gauge shows a pumping depth of about 4 feet over the end of the suction-pipe, which is 17 feet 3 inches below the level of high water of ordinary spring-tides; in other words, the water-level is lowered about 20 feet.

The adits are in the Middle Chalk; the main one, 224 yards long, is in a west-south-westerly direction, towards the Dour, the end being about 400 yards from the river; the other is in the opposite direction.

The water comes into the adits through fissures from the north-west; some of them are of considerable size, and have been opened out by continued pumping.

In 1862 it was reported that the bottom of the heading, then only 98 yards long, was covered, to the depth of about 15 inches, with chalk-sediment, for about 50 yards from the pumping-well. There is a strong clay-band in the adits for the greater part of the length; but flints are rarely found. The clay-bands hold up the water and are a source of danger in excavating, when they are near the roof-level, because the foot or so of chalk immediately below is apt to fall.

The north-eastern adit was driven in the winter of 1905 and in the spring of 1906. It is 106 yards long.

The yield is about 1,700,000 thousand gallons a day, about nine-tenths coming from the western adit. There are only three springs in the north-easterly adit, yielding 187,000 gallons a day. The adits hold about 230,000 gallons and form a useful reservoir. The water is good.

The supply in 1906 was as follows:—For domestic purposes 348,277,000 gallons. By meter (for trade-purposes) 78,000,000. For municipal purposes 20,000,000. The highest week's consumption was 9,795,064, in July. (Water Works Directory, 1907).

5. WESTERN HEIGHTS.

426 feet deep. Adit 15¾ feet below Ordnance Datum, in hard grey chalk.

Rest-level of the water (March) 4¼ feet above Ordnance Datum; but there is considerable variation. Yield about 168,000 gallons a day.

In Mr. S. C. HOMERSHAM's Report to the Directors of the London (Watford) Spring Water Company, Ed. 3, 1850, p. 52, it is said that "In the bottom of the well at Dover Castle, which is 315 feet deep, the current of water towards the sea may be distinctly seen. When the well for the supply of the western heights . . . was first sunk to the depth of low water, the rock proved so dense that no water percolated through, and in consequence, a horizontal gallery was driven at the bottom. . . . after proceeding some distance, a workman observed a small stream of water to follow the withdrawal of his pick-axe; on the next blow this stream was very much increased; and on the third there issued such a rush that the workmen escaped from the well with difficulty, for the water filled the shaft nearly as fast as they could be drawn up."

Dunton Green, *see* **Otford**.

East Barming.

Ordn. Map 288, new ser.; Geol. Map 6.

1. Two and a half miles from Maidstone.

From Dr. MITCHELL'S MSS. (in Libr. Geol. Soc.), vol. iii., p. 203. (*Rochester Naturalist*, 1901.)

Shaft 127 feet, the rest bored.

Kentish Rag and Sandstone	120	187 feet
Sand	3	
Blue clay, to sand	64	

2. MAIDSTONE WATERWORKS, by the Medway and East Farleigh Station. Abandoned.

Borehole supposed to be 600 feet deep. Well, 348 feet in March, 1898, with much sand.

Normal water-level 20 feet down. Pumped down to 150 feet at time noted above. Water very thick. When there (on March 7th, 1898), the water-level was about 3½ feet above the level of the river.

If the boring is as deep as said, the Tunbridge Wells Sand may have been reached.

Eastchurch (SHEPPEY). SHEERINGS, MR. HIGGS? 1900.

Ordn. Map 273, new ser.; Geol. Map 3.

Bored and communicated by Messrs. ISLER & Co.

Lined with 220 feet of tubes, of 7¼ inches diameter, from 74 feet down, and with 30 feet, of 6 inches diameter (10 feet perforated), from 285 feet down.

Water-level 49 feet down. Yield 3,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
	Well (? old, the rest bored) ...	—	83
[London Clay]	Brown clay ...	175	258
	Blue clay	41	299
[? Oldhaven Beds]	Green sand ...	15	314
	Clay and pebbles	1	315

East Langdon. EAST KENT WATERWORKS, north-west of the hamlet of Martin, on the road to West Langdon.

Ordn. Map 290, new ser.; Geol. Map 3.

Communicated by Mr. F. L. BALL and from a visit.

Engine-room floor 287 feet above Ordnance Datum.

Shaft 250 feet, with headings at the bottom, running south-south-west for about 500 feet (being extended).

All in Upper Chalk, with flints. Some silicified wood in one flint, from heading.

Standing-level of water 234 feet down (53 feet above Ordnance Datum), lowered to 246 feet by pumping. About 100,000 gallons a day pumped. Over 5,000,000 gallons a week have been pumped (during construction ?).

Apparently no effect is felt from the pumping of the Deal and Walmer Works, about 2¾ miles north-north-east.

The parishes supplied are Coldred, East Langdon, Ewell, Eythorne, Guston, Little Mongeham (part), Ringwold, Ripple, River, St. Margaret's, Shepherdswell, Sutton, Tilmanstone, Waldershare (part), and West Cliffe. Yearly supply 32 million gallons.

Eastry. WATERWORKS, *see* **Woodnesborough.**

East Wickham.

Ordn. Map 271, new ser.; Geol. Maps 1 S.W., London and its Environs, and London District, Sheet 4 (new.)
J. LUCAS. *Journ. Soc. Arts*, vol. xxv., p. 607.

	Height above O.D.	Water-level.	Depth to Chalk.
	Ft.	Ft.	Ft.
Cemetery Cottages	107	93	46¾
Russell Cottage ...	47·5	35	17
Suffolk Place .	49·7	45	24

In Dr. J. MITCHELL'S MSS., vol. 4, p. 464 (in *Libr. Geol. Soc.*) it is stated that a well at Shoulder of Mutton Heath passed through 5 layers of rock, from 12 to 15 inches thick, separated by beds of loamy sand, altogether 35 feet. One would have expected pebble-beds.

Edenbridge. STANGROVE, just north-north-west of the town. For Mr. A. BOWMAN. 1882.

Ordn. Map 287, new ser.; Geol. Map 6.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 22 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Dug well (the rest bored) ...		—	18
[Weald Clay]	Blue marl and stone ...	20	38
	Blue marl and bands of sandstone	29	67

Egerton. THE VICARAGE.

Ordn. Map 288, new ser.; Geol. Map 3 or 6.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 62 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Soil ...		2	2
[Lower Greensand. Hythe Beds or Kentish Rag]	Ragstone ...	3	5
	Sandstone ...	1	6
	Rag ...	1½	7½
	Sand and thin bands of stone	6½	14
	Sandstone ...	1	15
	Rag ...	10	25
	Sand ...	1	26
	Rag ...	4¼	30¼
	Sand ...	1¾	32
	Rag ...	1½	33½
	Sand ...	1	34½
	Rag ...	1½	36
	Sand and stone ...	2	38
	Rag ...	1½	39½
	Sand and stone ...	6½	46
	Rag ...	1	47
	Sand and stone ...	6	53
	Loamy sand ...	3	56
	Rag ...	1	57
	Sand and stone ...	2	59
	Sharp sand and stone ...	11½	70½

Elmers End. *see* Beckenham.

Elmsted. VICARAGE, in the garden. 1884.

Ordn. Map 289, new ser.; Geol. Map 3.

Information from the Rev. G. A. COLLETT, in paper by G. DOWKER, *Geol. Mag.* 1887, p. 212.

Shaft. 500 feet above Ordnance Datum.

Water first reached at 180 feet. A good head at the bottom.

Stones, clays, etc....	11	243 feet
Chalk without flints	232	

The chalk was so hard that it had to be blasted. Joints were few and far between. Below 220 feet the chalk was more jointed and more easily worked.

The water-level here is usually highest in May and then falls till January, when it rises again. In December, 1884, the well was dry and kept so till January 13th, 1885. The next morning there were 14 feet of water, which soon increased to 40.

Eltham.

Ordn. Map 271, new ser.; Geol. Maps 1 S.W., London and its Environs, and London District, Sheet 4 (new.)

1. Close to the Church. 1871.

Sunk and communicated by Messrs. S. F. BAKER & SONS.

To Chalk	103	200 feet
In Chalk	97	

2. Dr. KING'S GARDEN, corner of the Woolwich road, west of the Church. 1861.

Communicated by Mr. HAWORTH, Surveyor to the Local Board, Eltham.

Water rose to within 17 feet of the surface.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil	... ...	1	8	1	8
[Blackheath Beds ?]	Pebble-bed	2	0	3	8
	Red sand and gravel...	3	0	6	8
[Woolwich Beds]	Mottled clay	4	0	10	8
	Blue clay	7	0	17	8
	Blue clay with a good deal of sand	3	0	20	8
	Red sand with pebbles	1	6	22	2
	Woolwich shell-bed	11	7	33	9
	Mottled clay (marl)	8	9	42	6
	Black clay, like peat [lignite] ...	1	0	43	6
	Green sand	2	9	46	3

3. THE MOAT. Mr. R. Mill's field, near the proposed site of the Railway Station.

Communicated by Mr. HAWORTH, who had the note of the section from Dr. KING.

		Ft.
Black mould and gravel intermixed ...		100
[Blackheath Beds ?]	Gravel [pebbles ?]...	
[Woolwich Beds ?]	Yellow clay... ...	
	White sand... ...	
	Green sand... ...	
[Thanet Sand ?]	Soft red sand ...	
	Band of oxide of iron	
	Flints	
Chalk		10

4. THE PARK.

Communicated by Mr. T. JACKSON.
Water rises about 40 feet.

		Thickness.	Depth.
		Ft.	Ft.
[Oldhaven Beds] Ferruginous quartzose sand [? with pebbles in the lower part]...		44	44
[Woolwich Beds, 26 feet]	Yellow mottled clay with white fragments of shells	6	50
	Green sand	10	60
	Black pebble-bed	10	70
[Thanet] sand, nearly white		52	122
Chalk		94	216

5. Mr. TUCK'S, at the eastern end of the village?

Communicated by Mr. HAWORTH.
Sunk 44 feet, the rest bored. Water stood 25 feet above the bottom.

		Thickness.	Depth.
		Ft.	Ft.
Black mould and gravel intermixed [soil, &c.]		7	7
[Blackheath Beds ?] Gravel [pebbles ?] ...		4	11
[Woolwich Beds? 62½ feet]	Yellow clay...	2½	13½
	White sand...	60	73½
[Thanet Sand, 49 feet]	Green sand, very hard ...	40	113½
	Soft red sand	4	117½
	Band of oxide of iron ...	½	118
	Flints	4	122½
Chalk		44½	167

[The "white sand" must surely include the clay shell-beds.]

6. WELL HALL, just north of the village.

Boring (made by Mr. DOCWRA) in the hollow part of the field, near the stile on the path from the Woolwich road to Kidbrooke, and close to the road.
Communicated by Mr. HAWORTH.

		Thickness.	Depth.
		Ft.	Ft.
[Oldhaven Beds ?] Red sand with pebbles ...		19	19
[Woolwich Beds, 23 feet]	Shell-beds	6	25
	Mottled clay	5	30
	Black clay like peat [lignite]	1	31
	Green sand	5	36
	Brown sand	6	42
White [Thanet] sand, to chalk		63	105

Erith.

Ordn. Maps 257, 287, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new.)

1. ABBEY WOOD. The Harrow Inn.

Communicated by Mr. W. MORRIS.
About 13 feet above Ordnance Datum.
Shaft. Water-level 21 feet down.

Steined to Chalk	24	26 feet
Chalk	2	

2. Messrs. CANNON & GAZE'S FLOUR MILL. By the Thames, eastward of the Railway Station. About 1890.

Shaft 16 or 20 feet. Bored to 150.

Water stands at 18 feet, or about Ordnance Datum.

60 gallons a minute got=86,000 a day, pumping day and night, water-level not lowered, neither is it affected by the tide.

There is an old well 30 feet deep.

The water is softened for the boilers.

To Chalk 15 feet.

3, 4. CROSSNESS. Southern Outfall Works.

Report by the Engineer (Metropolitan Board of Works) on the boring operations. 8vo. *London*. 1869.

Level of original surface 5 feet above Ordnance Datum; present surface 12 feet higher (made ground, boring platform, &c.).

5-feet cylinders 84½ feet down, 18-inch pipe a few feet into the Chalk, 18-inch bore down to 718 feet, then much smaller.

[Sulphuretted hydrogen was given off from one of the borings here.]

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 22½ feet]	Alluvial deposit	1½	1½
	Light-brown clay	3½	5
	Blue silty clay, with vegetable matter	3¾	8¾
	Peat, with remains of trees... ...	6¼	15
	Dark grey silty clay...	1½	16½
	Thin layers of peat and clay, with decayed wood full of blue bloom [phosphate of iron]	1½	18
	Dark grey silty clay...	2½	20½
	Silty sand	2	22½
[Valley Drift and Blackheath Beds ?] Grey sub-angular flint-gravel, sometimes running sand, with iron pyrites [?] and blue clay		49	71½
[? Blackheath Beds or Woolwich Beds]	Sand with flints [? pebbles] and shells, very hard	11½	83
	Fine sand with flints [?], pebbles, and small shells	4½	87½
[Woolwich Beds]	Fine green sand	1	89
	Fine grey sand with small flint [? pebbles]	2¾	91¾
	Fine dark sand and flints [? pebbles]	9¾	101½
[Thanet Sand, 32 feet]	Fine light-coloured sand	35½	137
	Sand bound together by iron ...	5	142
	Loam and pebbles [? green-coated flints]...	1½	143½
Chalk, 646½ feet	Layer of flints...	½	144
	Chalk with layers of flints, at first about 8 feet apart, then from 2½ to 6 feet apart	446	590
	Chalk Marl [?] with few flints ...	200	790
[Upper Greensand ?] Sandy green marl		12	802
Gault clay		148	950

Second Boring, 1877. 1,050 yards south of the former.

Over 6 feet above Ordnance Datum ?

Prestwich, *Quart. Journ. Geol. Soc.*, vol. xxxiv., p. 913 (1878), and communication from Messrs. Docwra.

		Thickness.	Depth.
		Ft.	Ft.
Alluvium, 21 feet	Soil	1	1
	Dark brown stiff clay	3·75	4·75
	Blue silty clay	3·83	8·58
	Peat	6·42	15
	Blue silty sand	6	21
River gravel	... ...	18	39
Woolwich and Reading Beds, 47 feet	Very hard stiff blue clay	2·5	41·5
	Stiff yellow clay and sand layers ...	1·5	43
	Hard grey sand, with layers of tenacious clay of various hues, and of shells [divided by Prestwich, apparently by mistake, into two beds]	10·5	53·5
	Hard sand with layers of clay ...	1·25	54·75
	Stiff hard sandy clay	3·75	58·5
	Very hard, stiff sandy clay... ...	1·66	60·16
	Dark tenacious sandy clay	3·59	63·75
	Very stiff hard clay	2	65·75
	Dark green sand	1·5	67·25
	Dark green sand and shells... ...	·59	67·84
	Shell-bed	1·91	69·75
	Dark green sand, with pebbles of various sizes	3·75	73·5
	Dark green sand	·5	74
	Green clayey sand	2	76
	Green clayey sand and pebbles ...	1	77
	Green clayey sand and few pebbles	3	80
	Green clayey sand	1	81
	Greenish grey sand and pebbles ...	5	86
Thanet Sand, 51 feet	Sand	50·5	136·5
	Green flints	·5	137
Chalk, with a few layers of flint, and rock, and Chalk Marl. [Given as 637 feet by Prestwich, by mistake]		631	768
Upper Greensand. [No details given; but, as Prestwich remarks, "should probably be reduced, and the thickness of the Chalk increased." Probably the greater part belongs to the Chalk Marl]		65	833
Gault. Clay, the lower part full of stones, shells, and pyrites. [Specimen of phosphatic nodule from the bottom]		175	1,008
Red Rocks, 52 feet. Given, by mistake, as 60 feet.	Hard red rock-shale, micaceous ...	8	1,016
	Very hard grey rock, micaceous ...	4	1,020
	Dark red clayey shale-rock... ...	7	1,027
	Very hard quartzose red and grey rock	7·5	1,034·5
	Very hard quartzose greenish-grey rock	7·5	1,042
	Light-red shale	2	1,044
	Greenish-grey shale	4	1,048
	Very sharp grey sand, with black grains	12	1,060

The details of the Red Rocks given me by Messrs. DOCWRA differ from the above, being as follows:—

Sandstone, very hard ...	13	57 feet
Grey sand	4	
Red marl-rock	18	
Grey sand-rock	4	
Red marl with blue veins	3	
Grey marl	2	
Grey sand-rock	11	
Red marl with blue veins	2	

Whilst PRESTWICH was disposed to class the Red Rocks as Old Red I was inclined rather to look on them as New Red, some of the specimens seen being like the well-known red marl of the latter age.

5. ERITH MARSHES. Brown's Manure Manufactory (now Collins' Glue Works). 1890.

Communicated by Mr. J. GRANT, of the Metropolitan Board of Works.
About 5 feet above Ordnance Datum.

To Chalk	85	295 feet
In Chalk	210	

6. ERITH MARSHES. Messrs. Marshall & Co. (now Messrs Proctor & Bevington, 1890). 1875.

Made and communicated by Messrs. LE GRAND and SUTCLIFF
Bored throughout.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay, peat, bluish clay, and blue silt	18	18
	River silt	13	31
[River] Gravel ...	... ...	12	43
[London Clay, 23 feet]	Blue clay	20	63
	Sandy clay	3	66
[Blackheath Beds]	Black pebbles	20	86
[Woolwich Beds, 38 feet]	Shale and clay...	7	93
	Hard blue clay	5	98
	Green sand and pebbles	4	102
	Pebbles...	12	114
	Green sand	10	124
[Thanet Sand, 56 feet]	Dark grey sand	15	139
	Live sand	19	158
	Hard sand	22	180
Flints and chalk...	... ...	70 ft. 10 in.	250 ft. 10 in.

7. ERITH MARSHES. Paraffin Works. 1867.

Made and communicated by Messrs. TILLEY.

		Thickness.	Depth.
		Ft.	Ft.
Well sunk (the rest bored)		—	30
[? River Drift, or Blackheath Beds] Gravel		16	46
[Blackheath Beds]	White sand	8½	54½
	Hard black [flint] pebbles ...	2	56½
[Woolwich Beds]	Green sand and pebbles ...	40	96½
[Thanet Sand, 44½ feet]	Grey loamy sand, with stones	20	116½
	Grey loamy sand	24	140½
	Flints	½	141
Chalk and flints ...	... ...	124	265

8. Erith Marshes. Messrs. Price & Co.'s Mineral Oil Works. 1878.

Sunk and communicated by Messrs. Doowra & Son.
Cylinders to 41 feet, the rest bored.
Water pumped down to below 43 feet from the surface.

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
Made ground	... ...	1	6	1	6
Soil...	... ...	2	0	3	6
[Alluvium, 29 feet]	River-mud	9	0	12	6
	Peat	9	0	21	6
	Silt and clay	7	0	28	6
	Black peat and timber	3	0	31	6
	"Bungham" (hard mud)	1	0	32	6
[River Gravel]	Ballast	17	6	50	0
[? London Clay*]	Hard sandy clay...	9	0	59	0
[? Blackheath Beds,* 10 feet]	Black [flint] pebbles...	2	6	61	6
	Hard sand-rock	0	6	62	0
	Soft sucking sand	5	0	67	0
	Brown [flint] pebbles	2	0	69	0
[? Woolwich Beds,* 33½ feet]	Hard green sand	3	6	72	6
	Live sand	4	0	76	6
	Hard sand	26	0	102	6
[Thanet Sand, 43 feet]	Soft dark sucking sand	4	6	107	0
	Hard sand	33	6	140	6
	Tough black [? green] clay and sand	4	0	144	6
	Green flints	1	0	145	6
[Chalk, with flints, 269½ (? 274) feet]	Chalk, with few flints	14	6	160	0
	Chalk, with layer of flints at top and at bottom	14	0	174	0
	Soft loose chalk	1	6	175	6
	Chalk, full of water, with layer of flints at top and at bottom ...	10	0	185	6
	Chalk, with few flints	13	9	199	3
	Mild chalk, with flints at top and a foot of flints and water at bottom	8	9	208	0
	Flints and chalk	4	0	212	0
	Flints and mild chalk	6	0	218	0
	Mild chalk, with a foot of flints and water at top...	5	0	223	0
	Chalk, with flint-layers at top, at middle, and at bottom	9	6	232	6
	Hard chalk, with 4 layers of flints (2 watery)	25	9	258	3
	Chalk	5	6	263	9
	Rock-chalk	1	6	265	3
	Mild chalk, with flint-layer in middle	8	9	274	0
	Chalk, with 4 layers of flints (top, bottom, and middle)	15	0	289	0
	Chalk and flints	7	0	296	0
	Soft chalk and flints (a foot layer in middle)	10	6	306	6
	Chalk and flints, with 4 layers of flints	16	3	322	9
	Soft chalk, with 2 layers of flints ...	9	9	332	6
	Chalk, with 3 layers of flints, and flints in parts	19	6	352	0
	Watery yellow sand...	1	6	353	6
	Soft chalk, with 2 layers of flints ...	8	9	362	3
	Chalk-rock	1	6	363	9
	Soft chalk	4	6	368	3
	Chalk and flints, with layer of flints at top and at bottom	13	3	381	6

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* There is some difficulty about these three divisions. Possibly there is no London Clay.

		Thickness.		Depth.	
		Ft.	In.	Ft.	In.
[Chalk, with flints, 269½ (? 274) feet]	Grey marl	1	3	382	9
	Chalk, flints, and water	4	3	387	0
	Chalk and flints, with layer of flint at top and at bottom	6	9	393	9
	Hard chalk and flints, with flint at bottom	7	0	400	9
	Mild grey chalk, with 2 foot-layers of flints	9	9	410	6
	Grey chalk, with foot-layer of flints at top and at bottom	4	6	415	0
[Chalk, without flints, 45½ feet]	Hard grey sandstone...	3	6	418	6
	Soft chalk	1	3	419	9
	Hard grey sandstone...	2	3	422	0
	Grey marl	1	0	423	0
	Bluish rock	2	6	425	6
	Grey marly chalk	4	6	430	0
	Soft grey chalk	1	0	431	0
	Marly chalk, with soft marl at bottom	4	9	435	9
	Hard chalk	12	6	448	3
	Hard blue rock	2	9	451	0
	Rock, with 6 inch layers of marl at top, at middle, and at bottom ...	6	6	457	6
	Hard rock	2	6	460	0

The total is given as 465 feet. If there be an error in the details it is between the depths of 301 and 399 feet.

Mr. Jukes-Browne remarks that "the bottom 45½ feet seem to be like the zones of *Holaster planus* and of *Micraster corbovis*, at Dover; but nothing definite can be said."

9. Maxim-Nordenfeldt Guns Co. 1896.

Made and communicated by Messrs. Isler & Co.

Lined with 40 feet of tubes, of 8½ inches diameter, from 3 feet down, and with 100 feet, of 7¼ inches diameter, from 2¾ feet above the surface.

Yield 10,000 gallons an hour.

Well 5 feet, and then a boring of 245 feet, in Chalk.

According to a note by Mr. W. Topley, there are three wells here not over 20 feet deep; the water-level is about 5 feet down; and the level of the water is affected by the tide.

10. Messrs. Vickers, Sons & Maxim. In the large old pit south of the railway.

Made and communicated (1901) by Messrs. Isler & Co.

Lined with 60 feet of tubes, of 20 inches diameter, 5½ feet down.

Water-level 12 feet down. Yield 38,700 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		5½	5½
[Upper Chalk]	Chalk, with 6 inches of flint at the base ...	15	20½
	Chalk and flints ...	97½	118
	Flints	3	121
	Chalk and flints ...	26	147
	Flints	3½	150½
	Chalk and flints ...	47½	198
	Flints	4	202
	Chalk and flints ...	30	232
	Chalk	18	250

11. WORKS OF THE MINERAL OIL CO. 1865.

Sunk and communicated by Messrs. S. F. BAKER & SONS.

		Thickness.	Depth.
		Ft.	Ft.
Mould ...	... ...	1	1
[Alluvium, 33 feet]	Brown clay	3	4
	Clay and peat... ...	8	12
	Peat	20	32
	Shells and sand ...	2	34
[River] Gravel ...	... ...	12	46
[Woolwich Beds, 24 feet]	Shells and green sand	14	60
	Pebbles	3	63
	Black sand	7	70
Brown [Thanet] sand, to chalk	...	76	146

12. BRITISH FIRE LIGHTER CO. On the Marshes above the town below Callender's Works.

Communicated by Mr. C. BEADLE, who had the information verbally.

Well sealed for 90 feet. Water stands 10 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay	5	5
	Peat	17	22
[River Gravel]	Ballast	20	42
[? What]	Gault (= clay) ...	38	80
[Upper Chalk]	Chalk and flints	10	90
	Chalk	90	180

Mr. BEADLE adds that the water was found to contain 175 grains of chlorine per gallon, equal to over 25 per cent. of river-water.

13. MESSRS. FRASER & CHALMERS. 1907.

Made and communicated by Messrs. ISLER & Co.

Begun March 16th. Finished April 17th.

Lined with 20 feet of tubes, of 2 feet diameter, 6¾ feet down.

Water-level in the bore-hole 11½ feet down. Supply 40,000 gallons an hour.

Made ground ...	1	209⅓ feet
Loamy sand ...	7	
Chalk and flints	201⅓	

14. ERITH OIL WORKS. Quicklitt Wharf. Belvedere Marshes. Near the River, half a mile northward of St. John's Church.

1908 ?

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 5½ feet down.

		Thickness. Ft.	Depth. Ft.
[Alluvium]	Clay	5	5
	Peat	28	33
[River Gravel]	Ballast	16	49
[Thanet Sand]	Sand	31	80
	Flints	1	81
[? Upper Chalk]	Chalk and flints ...	109	190
	,, ,, ,, sticky	199	389
	Chalk and flints ...	21	410
	,, ,, ,, sticky	146	556
[? Middle and Lower Chalk]	Chalk, hard	13	569
	,, very hard ...	4½	573½
	,, hard	7½	581
	,, sticky	21	602

Plenty of water in the Chalk at first, but salt and useless. Then pipes were driven down to 180 feet, shutting out this water. Much better water was then got, but in a very limited quantity.

Second boring; about 800 feet W. and 700 feet N. of the first. Same authority.
Water-level 5½ feet down.

		Thickness. Ft.	Depth. Ft.
[Alluvium]	Soil and clay	6	6
	Peat and wood	20	26
[River Drift, 20 feet]	Sand and stones	2	28
	Sand	6	34
	Ballast [gravel]	12	46
[Upper Chalk, 341 feet]	Chalk and flints	234	280
	Sticky chalk and flints	107	387

The absence of Thanet Sand in this boring is notable and unexpected. Other borings in the neighbourhood show a greater depth to the Chalk than in these two. The Chalk gave trouble nearly throughout, by swelling and falling in.

Farnborough.

Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4 (new).

1. LOCKS BOTTOM.

Sunk and communicated by Messrs. S. F. BAKER & SONS.
Chalk at 123 feet.

2. WATERWORKS OF THE METROPOLITAN WATER BOARD, often called the Orpington Works, as being about a third of a mile south-east of Orpington Railway Station.

Communicated by Mr. W. MORRIS, Engineer to the Kent Waterworks Co., and from his Report prepared for the Metropolitan Water Board Arbitrators.

213 feet above Ordnance Datum.

Two wells (shafts and cylinders to about 90 feet) about 105 feet deep, No. 1 connected to one of the borings by a heading 60 feet long, from centre to centre. No. 2 connected with the other boring by a heading 97 feet long, from centre to centre. The first boring 213 feet deep in a shaft of 32 feet and with a short lining; the second 250, in a shaft of 30 feet, and lined to 200 feet.

Water-level varies from 14 feet to 47 feet down. A well near by shows a variation of 40 feet. The yield varies from 2,000,000 to 3,000,000 gallons a day.

			Ft.
[Valley Drift varying in character]	Loam ... ... Loam with flints Clean sharp flints Loam with flints	in shaft of borehole ...	19
		in shaft southern side	24
		in shaft northern side	27
[Upper] Chalk			to 250

Faversham.

Ordn. Maps 273, 289, new ser.; Geol. Map 3.

1. ABBEY BRICKYARD (Mr. H. Chambers).

An 18-inch boring.

Made and communicated by Mr. R. D. BATCHELOR. (*S.E. Naturalist*, 1902.)

Water-level 15 to 20 feet above Ordnance Datum.

Yield about 30,000 gallons an hour (? tested up to 35,000).

Bullhead chalk	15	94 feet
Chalk and flints	79	

2. RAILWAY STATION. 1898.

Made and communicated by Mr. R. D. BATCHELOR. (*S.E. Naturalist*, 1902.)

Water-level 52 feet down.

	Thickness.	Depth.
	Ft.	Ft.
Well (old) [? River Drift and Chalk], the rest bored	—	44
Chalk and flint	246	290
Chalk	26	316
Chalk and flint	9	325
Chalk	$21\frac{3}{4}$	$346\frac{3}{4}$

3, 4. WATERWORKS. On the western side of the road to Ashford, five-sixths of a mile southward of the Railway Station. 1864.

About 130 feet above Ordnance Datum.

Communicated by the Secretary, Mr. F. F. GIRAUD. (*S.E. Naturalist*, 1902).

Water rises to a height of 25 feet, being 65 feet above the level of the creek.

Daily yield (24 hours) 200,000 gallons.

Brickearth	25	113 feet
Chalk ...	88	

1900 (? second well).

Made and communicated by Mr. R. D. BATCHELOR. (*S.E. Naturalist*, 1902.)

Shaft of 9 feet diameter. Headings to old well, 76 by $5\frac{1}{2}$ by 4 feet. There are headings to the west, about 250 yards.

Water-level 100 feet down.

	Thickness.	Depth.
	Ft.	Ft.
Mould	1	1
Brickearth	$4\frac{1}{2}$	$5\frac{1}{2}$
Loam	$24\frac{1}{2}$	30
Flint	1	31
[Upper] Chalk and flint	104	135

Supplies also Oare, Ospringe and Preston. Yearly supply (1906) 102,400,000 gallons. Highest day's consumption 302,000 gallons, in December. (Water Works Directory, 1907.)

Fawkham.

Ordn. Map 271, new ser.; Geol. Map 6.

1. FAWKHAM MANOR.

Communicated by Messrs. ISLER & Co. (*Rochester Naturalist*, 1901.)
Shaft 300 feet. Bored 100½ feet, all Chalk.
Water-level 300 feet down.
Supply abundant at first, but Mr. F. L. BALL told me, in 1902, that the supply had given out.

2. Mr. J. J. HICKMOTT'S BRICKWORKS.

Made and communicated by Mr. R. D. BATCHELOR.
(*Rochester Naturalist*, 1901.)
Much water from the boring (9 inches in diameter).

		Thickness.	Depth.
		Ft.	Ft.
Old Well (Chalk), the rest a 9-inch boring		—	150
[? Upper Chalk]	Hard chalk and flints ...	31	181
	White chalk, no water ...	50	231
	White chalk	32	263
	White chalk and flints ...	7	270
	White chalk	30	300

Folkestone.

Ordn. Map 305, new ser.; Geol. Maps 3, 4.

1. GASWORKS, 1901.

Made and communicated by Messrs. ISLER & Co.

Shaft 9 feet, the rest bored. Lined with 20 feet of tubes, of 10 inches diameter, from about 9 feet down; with 100 feet, of 8½ inches diameter, from 7½ feet down; and with 105 feet, of 7¼ inches diameter, partly perforated. Water-level 40 feet down. Yield 30 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Lower Greensand]	Sand and loam	9	9
	Hard blue rock	4	13
	Loam and sand	13	26
	Hard blue rock	3½	29½
	Blue rock	3	32½
	Light-coloured sand	4	36½
	Green sand and loam ...	44	80½
	Green sand and clay... ...	6½	87
	Hard grey rock	1	88
	Green sand and clay... ...	50	138
	Dark clay with a little sand	12	150
	Light-coloured loam	12	162
	Green sand with shells ...	1	163
	Green hard rock	19	182
	Light-coloured rock	6	188
	Light-coloured clay	9¾	197¾

2, 3. Hotel Metropole. Near the Cliff, on the Upper Sandgate Road. Trial-boring, 1896.

Bored and communicated by Messrs. Baker. (*S.E. Naturalist*, 1902.)
No record of shaft.

The sand blows very much when the head of water is taken off; once it blew as much as 60 feet in height.

		Thickness.	Depth.
		Ft.	Ft.
Shaft [Folkestone Beds, ? any Sandgate Beds]		—	71½
[Sandgate Beds]	Hard clay	18½	90
	Green sand	8½	98½
	Dark sand	18½	117
	Very hard clay	8	125
	Sandy clay	10	135
	Very hard clays	30	165
	Marl	3	168
[Hythe Beds]	Hard stone	1¼	169¼
	Sand, with water	2½	171¾
	Hard stone	¾	172½
	Sand, with water	1½	174
	Hard stone	¼	174¼
	Sand, with water	3¼	177½
	Hard stone	½	178

A later boring, made and communicated by Messrs. Isler & Co., 1901. (*S.E. Naturalist*, 1902.)

110 feet of tubes, of 8½ inches diameter, 8 feet down; 160 feet, of 7¼ inches diameter, 6 feet down; and 160 feet, of 6 inches diameter, 10 feet down.

Water-level 155 feet down. Supply, from rock below 170 feet, 1,000 gallons an hour. Water brackish.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Well		—		10	0
Folkestone Beds]	Hard sand	3	0	13	0
	Hard sand and slag [? ironstone]	11	6	24	6
	Grey rock	1	10	26	4
	Rock and sand	0	4	26	8
	Rock	0	4	27	0
	Rock and sand	13	6	40	6
	Rock	2	10	43	4
	Rock and sand	1	2	44	6
	Rock	6	6	51	0
[Sandgate Beds, 118 feet]	Green loamy sand	29	0	80	0
	Dark sand and clay	8	0	88	0
	Green sand	73	0	161	0
	Dead green sand	6	0	167	0
	Dead green sand and stone	1	6	168	6
	Dead green sand	0	6	169	0
[Hythe Beds]	Rock	15	0	184	0
	Light-grey marl	4	0	188	0
	Rock	4	0	192	0
Blue marl [? Atherfield Clay]		8	0	200	0

4. Messrs. Langton & Co.'s Brewery, Tontine Street, 1879.

Trial-boring, 28 feet above mean tide-level.
Made and communicated by Messrs. Le Grand and Sutcliff.
(*S.E. Naturalist*, 1902.)

The water in the upper beds was brackish, and rose nearly to the surface (22½ feet down at high tide and 29¼ feet at low tide) according to Mr. Lucas.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground		2	6	2	6
Gravel		8	0	10	6
[Folkestone Beds] Dead sand		15	6	26	0
[Sandgate Beds, 92 feet]	Green sand	24	0	50	0
	Dark or grey loamy sand	6	0	56	0
	Dead green sand	16	0	72	0
	Dead sand	16	0	88	0
	Hard dead green sand	8	0	96	0
	Dead green sand and clay	7	0	103	0
	Hard dead sand	8	0	111	0
	Hard green sand	7	0	118	0
[Hythe Beds, 28½ feet]	Rock	3	3	121	3
	Sandstone	2	9	124	0
	Rock	0	7	124	7
	Very hard rock	1	7	126	2
	Clay (and stone?)	1	9	127	11
	Hard rock	1	6	129	5
	Clay and rock	1	2	130	7
	Rock	0	8	131	3
	Hard rock	0	4	131	7
	Rock and clay	2	6	134	1
	Hard limestone	0	4	134	5
	Limestone-rock	0	8	135	1
	Limestone and clay	1	0	136	1
	Limestone-rock	1	10	137	11
	Stone and sandy clay	8	7	146	6
[Atherfield Clay, 38 feet]	Sandy clay	4	0	150	6
	Sandy clay with veins of stone	6	0	156	6
	Sandy clay	19	0	175	6
	Dark clay	9	0	184	6
Brown [Weald] clay		23	6	208	0

Another version, from information given by Mr. J. Lucas (to Mr. Topley, who made the classification now given), is as follows :—

		Thickness.	Depth.
		Ft.	Ft.
Made ground		11	11
[Folkestone Beds] Sand		4½	15½
[Sandgate Beds]	Greenish sand and dark sandy clay Dark sandy clay	101½	117
[?Sandgate or Hythe Beds]	Coarse sandstone	¾	117¾
	Green sandy clay	5¼	123
[Hythe Beds]	Dun limestone	1¾	124¾
	Green sandy clay	¾	125½
	Hard rock	2¼	127¾
	Light-grey clayey sand	1¼	129
	Light-grey limestone	1¾	130¾
	Light-grey clayey sand	¾	131½
	Stone bands and sandy partings	19½	151
Greyish [Atherfield] Clay, sometimes sandy		28	179
[Weald Clay]	Brown clay	10	189
	Grey clay	7	196

Mr. Lucas has given a less detailed account of this boring in *Trans. Inst. Surveyors*, vol. xiii., part v., pp. 173, 174, and part vi., plate. He notes that on November 20th, 1878, a small pump got 7 gallons of water a minute, but this was very salt, although the site is a quarter of a mile from the sea.

5. London Chatham and Dover Railway.

Trial-boring (4 inches diameter) at Tiddyman Step, for proposed extension from Kearsney Station to Folkestone.

Made and communicated by Mr. R. D. Batchelor. (*S.E. Naturalist*, 1902.)

Water-level 98 feet down. Only a slight soakage. Cut a little water at the top of the green sand.

		Thickness.	Depth.
		Ft.	Ft.
Mould...		3	3
[Lower Chalk]	Grey chalk	67	70
	Chalk marl	4	74
	Hard sandy grey chalk	20	94
	Chalk marl	8	102
	Hard green sand [basal bed of the Chalk]	15	117
Gault clay		9	126

6. Public Baths. Foord, 1897.

Boring made and communicated by Messrs. Isler & Co. (*S.E. Naturalist*, 1902.)

Lined with 60 feet of tubing, of 6 inches diameter, from a foot below the surface.

Water-level a foot down (later 16½ feet). Supply about 600 to 1,000 gallons an hour.

	Thickness.	Depth.
	Ft.	Ft.
Mould or made ground	3	3
Blue clay...	3	6
Rock and sand	2	8
Rock	4	12
Rock and sand	2	14
Sandy clay and flints	3	17
Hard rock	½	17½
Rock and clay	1½	19
Clay	1½	20½
Rock	1	21½
Sandy clay	43	64½
Green sandy clay	35½	100

7. Waterworks.

"The well at the Folkestone Water works, near the Cherry Gardens, was sunk through the Gault to the Lower Greensand; much of the phosphate bed may be seen there lying about." W. Topley, Geology of the Weald, p. 147 (1875).

Well 6, about half a mile south-westward of the earthwork on Castle Hill, 1895.
Communicated by Mr. H. TURNER, the engineer, with notes of specimens. (*S.E. Naturalist*, 1902.)
About 137 feet above Ordnance Datum. Shaft (of large size in the Gault) 136 feet, with headings from 78 to 86 feet; then a trial-bore.

		Thickness.	Depth
		Ft.	Ft.
	Gault	20	20
[Lower Greensand]	Rock, upper part soft, lower part hard	4	24
	Running sand. With the water great quantities of sand came in	29	53
	Hard sand	17	70
	Rock	2	72
	Hard sand and rock (from gallery, coarsely glauconitic calcareous stone, with an Ammonite in a less glauconitic piece)	14	86
	Hard sand	12	98
	Undescribed (dark grey sand, slightly greenish, with some bits of shells)	18	116
	Undescribed (sandstone with shells, wood and pyrites: piece of calcareous stone)	3	119
	Undescribed (dark grey sand, from about 126 feet)	17	136
	Boring, ? in sand, at the bottom very clayey ...	55	191

Wells 1-5 are eastward, 4 and 5 near by, 3 further off, 1 and 2 about a quarter of a mile off.

According to the Report of the Medical Officer of Health for 1904, the deep well in the Lower Greensand at the Shearway works has an average yield of 500,000 gallons a day, a further 300,000 being collected from a tunnel into the Chalk behind the reservoirs. See also pp. 64, 97.

The following places are also in the area of supply:—Cheriton and Shorncliffe Camp, Alkham, Capel-le-Ferne, Hawkinge, Lydden, and part of Sandgate. Quantity drawn in 1906:—From springs and adits, 86,632,000 gallons; from deep wells, Shearway, 62,974,000, Standen, 305,295,000. (Water Works Directory, 1907.)

NEW WORKS, *see* **Capel-le-Ferne.**

Foot's Cray. 1. Frognal. 2. Sandy's Cottage, near Ruxley.

Ordn. Map 271, new. ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4 (new).
Shafts. Communicated by Mr. W. MORRIS.

	1.		2.	
	Ft.		Ft.	
Level of road, above Ordnance Datum	189		147	
Water-level, from surface	81		75	
Steined, to chalk [? to firm chalk] ...	80	130	52	78
Chalk	50		26	

Frindsbury.

Ordn. Map 272, new ser.; Geol. Map 6.

1. BEAVER CEMENT WORKS.
15 feet above Ordnance Datum.
Made and communicated by Mr. R. D. BATCHELOR. (*Rochester Naturalist*, 1901.)

Shaft 19¾ feet, the rest an 18-inch boring.
Yield 17,920 gallons an hour (? water-level about 10 feet down).

		Thickness.	Depth.
		Ft.	Ft.
	Loose chalk and flints	19¾	19¾
[Upper Chalk]	Soft chalk	1	20¾
	White chalk	3	23¾
	Hard chalk	8	31¾
	Very hard white chalk	5	36¾
	Chalk, with a few flints	7	43¾
	Rocky chalk	10	53¾
	Very hard chalk ...	24	77¾
	Hard marly chalk ...	4	81¾
	Chalk	29	110¾
	Chalk, with water ...	7	117¾
	Hard chalk	28	145¾

(The total is given as 200 feet).

2. CHATTENDEN BARRACKS, north of Upnor. 1885.

Communicated by Col. R. HAWTHORNE, R.E., Capt. W. W. ROBINSON, R.E. (see *The Royal Engineers' Journal*, vol. xvi., pp. 151, 152), and Capt. H. G. LYONS, R.E., with some later information by Col. C. W. SHERRAN (*Quart. Journ. Geol. Soc.*, vol. xlii., p. 33; vol. xliii., p. 198).

127 feet above Ordnance Datum.

Shaft and cylinders about 200 feet, the rest bored and lined to 302 feet, with tubes of 6 inches diameter, with tubes of 5 inches diameter to 1,064 feet, and with tubes of 4 inches diameter to 1,142½ feet.

Water from the three greenish sands (down to 123, 129¾, and 146 feet respectively) was ferruginous. The water from the Lower Greensand overflows from the bore-pipe into the well, and rises to about 114 feet from the surface, and after pumping two hours, at the rate of 5,000 gallons an hour, could not be lowered below about 170 feet.

In January, 1900, the boring became choked with *débris*, a specimen of which was fine greenish sand, clearly from below the Gault Clay. Late in 1900 the boring was slightly deepened.

		Thickness.	Depth.
		Ft.	Ft.
London Clay, 101 feet	Brownish clay...	16½	16½
	Blue clay	75½	92
	Greenish sand and blue clay ...	9	101
Oldhaven Beds.	Gravel with chalk [? white flint pebbles] and shells	7½	108½
Woolwich Beds, 59¾ feet	Fine sharp sand, with water ...	6½	115
	Green sand	3	118
	Greenish sand...	5	123
	Shells closely packed in blue clay...	5	128
	Hard black shale	1	129
	Fine green sand	¾	129¾
	Fine white sand	7	136¾
	Greenish sand, wet, and blowing from under cylinder	10	146¾
	Fine sand, almost on the move with water...	20½	167¼
	Blue clay, sand, and pebbles ...	1	168¼

		Thickness.	Depth
		Ft.	Ft.
Thanet Beds, 121¾ feet	Green sand	16¼	184½
	Blue sandy loam	105½	290
	Chalk. Specimens of clayey chalk (probably Chalk Marl) at 890, 905, 920, and 940 feet. No springs found. Base not noted. Presumable thickness, judging by the Chatham sections ... ... say	680 or 682	972 ?
	Gault, with some pyrites. Specimens, light-coloured clay at 1,100 and 1,130 feet, the latter with *Inoceramus* ; just above 1,140 feet a *Rostellaria* ; at 1,140 feet a phosphatic nodule, with the cast of the whorls of an *Ammonite*; about 1,140 feet a small phosphatic nodule, chiefly an *Ammonite* ; at 1,142 feet dark grey clay. For the last few feet the clay was dark, but with green grains. About 9 inches of rock at the bottom (specimen of phosphatic nodule, from 1,161 feet) ? about	192 or 190	1,162
	The chisel then dropped 3 feet, and water quickly rose to about 107 feet below the surface, some greenish sand being brought up in the first ebullition. Presumably, therefore, the Lower Greensand was touched. Sand rose about 60 feet up the tube, and a specimen of the earth being removed (in February, 1886), consisted of a mixture of Gault clay with some green sand.		
	Alternating thin layers of sandy and clayey substances (1900)	? 4	1,166

When the bottom of the tube was cleared out and the tubes were driven down into the sand, the water rose to within 100 feet of the surface.

The great thickness of the Thanet Beds here is notable, 121 feet being a good deal more than one would have expected.

Capt. LYONS has noticed, in a letter to me, that the section of the Tertiary Beds is almost identical with that of the neighbouring Upnor pits, and has classified the beds accordingly.

I had, some years before, an account of a shaft at Chattenden Barracks, which seems to be a different version of the top part of this well. It was taken from a drawing (dated 1876) communicated by the Inspector General of Fortifications, and is as follows:—

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 102 feet]	Brown clay	17	17
	Blue clay	85	102
[Oldhaven Beds, 10 feet]	Light-coloured silver-sand	5	107
	Shells, sand, and stones [? pebbles]	5	112
[Woolwich Beds]	Sand	8	120
	Shells, dark earth, and stones ...	2	122
	Sand and shells	10	132
	Green sand	1	133

Water was found in the Tertiary Beds, but not of good quality.

A perforated pipe, intended for the bottom of the boring, but which stuck about 10 feet up, was brought up and found to be honeycombed in places, as if by acids.

3. Quarry Cement Works.

(Associated Portland Cement Co.)

Close to the river 15 feet above Ordnance Datum.

Made and communicated by Mr. R. D. Batchelor. (*Rochester Naturalist*, 1901), to 527 feet.

Shaft 31 feet, the rest bored (18 inches diameter).

Yield 8,000 gallons an hour (? water-level about 10 feet down).

Then from Messrs. Isler & Co. and Mr. W. L. Gadd. (1907, 1908).

Boring started (from old bore) at 560 feet down.

25 feet of tubes, of 13½ inches diameter; 4 feet down; then 700 feet, of 13 inches diameter, and 87¾ feet, of 10 inches diameter perforated, 690 feet down; 65 feet, of 8½ inches diameter, at 747 feet.

		Thickness.	Depth.
		Ft.	Ft.
	Chalk	6	6
	Rubble chalk	5	11
[Upper Middle and Lower Chalk]	Blocky chalk	4	15
	Chalk and flints	152	167
	Chalk	98	265
	Hard chalk	102	367
	Chalk	72	439
	Hard chalk	16	455
	Dark chalk	2	457
	Hard chalk	57	514
	Grey chalk	10	524
	Grey chalk and sand...	2	526
	Upper green sand [base-bed of Chalk]	1	527
	? Chalk...	23	550
[Gault]	Blue gault ... ... about	115	665
	Grey gault	65	730
[Lower Greensand]	Sand-rock	4	734
	Green sand	9	743
	Sandstone-rock	?3	?746
	Grey sand	12	758
	Green sand	53	811
	Sandstone	2	813
	Rock	20¼	833¼

Depth, 14 May, 1908, 852½. Water overflowing.

4. Whitewall Cement Works (Formby's). 1882.

Sunk and communicated by Messrs. Tilley. (*Quart. Journ. Geol. Soc.* vol. xlii., p. 32.)

30 feet above high-water mark.

Bored throughout, and lined with tubes from 6 to 4 inches in diameter.

Directly the rock was pierced water rose to the surface, throwing out a large quantity of sand and pebbles. It rose to a height of 61 feet above high-water-mark (? 30 feet above ground-level). The water is bright, free from sand, and has been analyzed by Dr. Voelcker (see p. 308).

Yield 60 gallons a minute. In December, 1885, the supply was as strong as when first tapped.

		Thickness.	Depth.
		Ft.	Ft.
Chalk		618	618
[Gault, 192 feet]	Gault clay	189½	807½
	Rock ...	2½	810

To [Lower] Greensand, in which water was got at the depth of 815 feet, there being apparently a hollow, the tubes going freely 18 feet below where the tools had been.

Some of the tubes are said to have become magnetized, so that in lowering a bar it was pulled over to one side and held firmly; some of the boring-rods too were acted on in the same way.

Frith Estate, *see* Hadlow.

Frittenden.

Ordn. Map 304 or 288, new ser.; Geol. Map 6.
Information from Mr. T. Hayter Lewis to Sir J. Prestwich.

Yellow clay, with 2 or 3 very thin layers of stone	17	32½ feet
Blue marl varying very much in hardness. The water came from a rent in this, 6 feet from the bottom, and it drove the workmen away	15½	

? Gillingham. Darnett Ness.

Ordn. Map 272, new ser.; Geol. Map 6.
Boring made for, and communicated by, the War Office.

Sand, pebbles, loam, &c., about	170	218 feet
Chalk	48	

Waterworks, *see* Chatham.

Goudhurst. Village Well.

Ordn. Map 304, new ser.; Geol. Map 6.
Communicated by Mr. E. L. W. H. Smith (1888.)
The sinkers say that there is enough water of good quality, but Mr. Smith is inclined to consider the well a failure.
162 feet deep, leaving off in marl.

[? Wadhurst Clay]
Marl at the depth of 45 feet.
Fossil wood ,, 95 ,,
Shells ,, 118 ,,
Total depth, in marl, 162 ,,

Grain, Isle of.

Ordn. Map 272, new ser.; Geol. Map 1, S.E.

1. Fort. 1863.

Sunk and communicated by Messrs. Doowra. Further particulars from the Clerk of the Works at the spot.
21 feet above Ordnance Datum. Shaft 180 feet, the rest bored.
Water rose to a height of 20 feet below the surface.

		Thickness.	Depth.
		Ft.	Ft.
Blue [London] clay		300	300
[Oldhaven and Woolwich Beds]	Dark sand	8	308
	Light-coloured sand	12	320

Some of the sand full of dark grains, and with pieces of shells.

2. Rose Court Farm. 1900.

In the marshes, little above Ordnance Datum.
Made and communicated by Mr. R. D. Batchelor.
(*Rochester Naturalist*, 1900.)
Shaft, of 3 feet diameter, 9 feet, the rest bored, 8 inches diameter, reduced to 5 and 4 inches.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Mud and peat	24	24
[River Drift]	Sand and gravel	30	54
	Sand, gravel, and clay ...	7	61
[London Clay]	Clay	190	251
	Sandy clay	9	260
[Oldhaven Beds]	Dead sand	2	262
	Gravel [pebbles] and sand	3	265
[? Woolwich Beds]	Sand	10	275
	Hard sand	8	283
	Dead sand	14	297
	Sand	13	310

Gravesend.

Ordn. Map 271, new ser.; Geol. Maps 1, S.E., and London and its Environs.

1. Denton Hospital. 1884.

Made and communicated by Messrs. Le Grand and Sutcliff.
Water-level 8 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Dug pit		—	3½
Pipes driven		—	31
[? What]	Gravel ...	4	35
	Green clay	7	42
	Gravel ...	26	68
Chalk...		42	110

2. Electric Light Station.

Made and communicated by Messrs. Isler & Co.
Lined with 10 feet of tubes, of 7¼ inches diameter, 3½ feet down; and with 50 feet, of 6 inches diameter, level with the surface.
Water-level 10 feet down. Supply 7,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
	Made ground	6	6
[River Drift]	Blue clay	1½	7½
	Brown clay	1	8½
	Ballast [gravel]	5½	14
	Flint	1	15
	Ballast or bull-head [gravel]	2	17
	Chalk and flints	133	150

3. LONDON CHATHAM AND DOVER RAILWAY EXTENSION WORKS.

Made and communicated by Messrs. C. ISLER & Co.

Shaft 6 feet, the rest bored. Lined with 24 feet of tubes, of 5 inches diameter, up to surface.

Water-level 56 feet down. Supply abundant.

		Thickness.	Depth.
		Ft.	Ft.
Gravel		7	7
[Thanet Beds, 16½ feet]	Loamy sand	7½	14½
	Green sand	9	23½
Chalk		77	100½

4. Messrs. RUSSELL'S BREWERY. 1897.

Made and communicated by Messrs. ISLER & Co. (*Rochester Naturalist*, 1901.)

Lined with 35 feet of tubes, of 5 inches diameter, 4 feet down. Water-level 1½ feet down. Supply 4,000 gallons an hour.

Well [? old], the rest bored ...		16	120 feet
[Upper Chalk]	Chalk and flints	7	
	Chalk	97	

5. SHIP AND LOBSTER TAVERN, Milton. 1891.

By the river-wall.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.

		Thickness.	Depth.
		Ft.	Ft.
Dug well (the rest bored)		—	5
[Alluvium]	Clay and peat... ...	20	25
	Black sand	10	35
[River Drift]	Stones	3	38
	Clay and white marl	12	50
	Gravel and sand ...	15	65

6. THOMAS'S PAPER MILLS, Crete Hall, between the Thames and Rosherville Gardens (? in Northfleet).

Made and communicated by Mr. R. D. BATCHELOR. (*Rochester Naturalist*, 1901.)

Hole dug 11 feet, the rest an 18-inch bore.

Water-level 12¼ feet down. Yield 32,000 gallons an hour, lowering the water-level to 40 feet down.

Soil	2	146 feet
Chalk and flints	144	

7. WATERWORKS, 1836 (? before).

Rev. J. C. CLUTTERBUCK, "Snpply of Water to the Metropolis from the Valley of the Colne," Watford, 1842.

	Thickness.	Depth.
	Ft.	Ft.
[? Woolwich Beds] Loam and gravel	20	20
[Thanet] Sand	46	66
Chalk and flints	68	134

According to the Sixth Report of the Rivers Pollution Commission (1874, p. 348), the well is 200 feet deep, and the supply is 250 000 gallons a day in summer and 200,000 in winter.

Two later wells. 1899.

Made and communicated by Mr. R. D. BATCHELOR.
(*Rochester Naturalist*, 1901.)
No. 1. Shaft of 7 feet diameter, with headings of 246 feet.

	Thickness.	Depth.
	Ft.	Ft.
[? Woolwich and Thanet Beds] Sand ...	92	92
[Upper Chalk] Chalk	18	110
[Upper Chalk] Chalk and flints ...	50	160

No. 2. Shaft of 8 feet diameter.

	Thickness.	Depth.
	Ft.	Ft.
[? Woolwich and Thanet Beds] Sand	107½	107½
Chalk and flint	75½	183

These differ from the section of the old well in showing a greater depth to the Chalk. There are headings in the Chalk.

Milton and Northfleet are also supplied from these works.

8. WHITE HILL, Gravesend Sanatorium. 1887?

Made and communicated by Messrs. ISLER & Co.
Shaft 12 feet, the rest bored, with 40 feet of tubes, of 5 inches diameter, 10 feet down.
Water-level 146 feet down. Yield 600 gallons an hour.
Chalk and flints 235 feet.

Greenhithe.

HUNTER TAYLOR & SPOOR'S CEMENT WORKS, close to the Thames.

Ordn. Map 271 new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).
12-inch boring, made and communicated by Mr. R. D. BATCHELOR.
(*Rochester Naturalist*, 1901.)
Tested to 15,000 gallons an hour.

	Thickness.	Depth.
	Ft.	Ft.
[Alluvium] Clay and peat, charged with water	40	40
[River Drift] Dirty gravel	10½	50½
[Upper Chalk] Chalk	9½	60
[Upper Chalk] Chalk and flints ... ...nearly	102	162

Green Street Green, *see* Darenth.

Greenwich.

Ordn. Maps 270, 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).

1. BEEHIVE BREWERY, Church Street, near the Thames.

Communicated by Mrs. PAGE. (Wrongly printed as Gravesend in Memoirs, vol. iv.) The second column of figures is from MYLNE'S "Sections of the London Strata," and the third from Mr. F. BRAITHWAITE, *Proc. Inst. Civ. Eng.*, vol. v., p. 203.

Shaft 10 feet, the rest bored.

Water rises into the shaft, and the supply is continuous and abundant.

	Ft.	Ft.	Ft.
[Blackheath Beds ?] Gravel ... [Woolwich and Thanet Beds] Shells ... ... Blue clay (a little) Loam, of various colours (a good thickness)	120	130	124
Chalk, with many flints	124	150	152
Total...	244	280	276

2. BREWERY, close to the Railway Station.

Communicated by Messrs. LOVIBOND.

Shaft 22 feet, the rest bored. Water rises to within 11 feet of the surface

To Chalk	80	180 feet
In Chalk	100	

3. EAST STREET (Mr. Hill's). 1862.

Sunk and communicated by Messrs. S. F. BAKER & SONS.

		Thickness.	Depth.
		Ft.	Ft.
To the gravel		—	28
Gravel [? partly pebble-bed]		16	44
[? Blackheath Beds and ? partly Woolwich Beds]	Sand	5	49
	Pebbles, sand and shells ...	30	79
[Woolwich and Thanet Beds]	Green and grey sand to Chalk	80	159

4. HOSPITAL. Brewery, ? 1844, deepened 50 feet in 1864.

From Sheet 4 of the "Sections of Borings in the Metropolitan District," 1849, with additional information from the "Report of the Engineer (of the Metropolitan Board of Works) on the Boring Operations of the Crossness Pumping Station," 8vo., Lond. 1869, p. 61.

7 feet above Trinity high-water-mark.

? Shaft 155 feet, the rest an 18-inch bore.

Water rose to within 19 feet of the surface of the ground. Supply 120 gallons a minute.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground		11	0	11	0
Gravel [? in part Blackheath Beds]		33	0	44	0
[Woolwich, Beds, 23½ feet]	Black sand	4	10	48	10
	Blue clay (4 ft. 10 in. in the later account)	0	8	49	6
	Shelly rock (4 ft. 10 in. in the later account)	4	0	53	6
	Red clay	6	0	59	6
	White sand (water)	4	0	63	6
	Green sand and pebbles	4	0	67	6
[Thanet] sand (water)		55	10	123	4
Bed of flint [? Green-coated flints and the top flint-layer of the Chalk together]		1	0	124	4 or 6
Chalk with flints		180	6	305	0

The Rev. H. M. De la Condamine's account differs but little from the above, but is not so detailed. Instead of "made ground" he has "alluvium, 10 feet;" the thickness of the "gravel" he makes 35 feet; the top three beds of the Woolwich Series are given together as 9 feet thick; the lowest three in like manner as 12 feet; and the sand next above the chalk as 57 feet. *Quart. Journ. Geol. Soc.*, vol. vi., p. 448.

5. Observatory. "Flamsteed's Well," in the Garden, now covered.

Information from Mr. T. V. Holmes.

To Chalk	75	80 feet
In Chalk	5	

6. Ordnance Wharf, East Greenwich. 1886.

Made and communicated by Messrs. S. F. Baker & Son.
Shaft 50 feet, the rest bored. Water-level 18 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground and mould		22	22
[River Drift]	Black gravel	14	36
	Flinty rock	2	38
[London Clay ?]	Brown clay	13	51
	Brown clay and pebbles ...	1	52
?	Fine grey sand	1½	53½
	Limestone-rock	2	55½
	Mild limestone-rock ...	10	65½
	Grey marl	5	70½
[Woolwich Beds]	Shelly beds...	6	76½
	Sandy clay	17	93½
	Light-coloured sandy clay	6½	100
	Light-coloured pebbles ...	2	102
	Silty sand	2½	104½
	Black [flint] pebbles ...	15½	120
[Thanet Beds]	Thanet sand	33	153
	Brown clay	11	164
Chalk, with flints		158	322

7. Union Workhouse.

Dr. J. Mitchell's MSS., vol. iv., opp. p. 56. The details seem doubtful.

	Thickness.	Depth.
	Ft.	Ft.
Earth ...	5	5
Gravel ...	2	7
Blue clay ...	30	37
Coloured clay	6	43
Sand... ...	11	54
Chalk ...	30	84

At the Infirmary, adjoining the Workhouse on its western side, the section of the well is as follows, according to Dr. Bulstrode, through Mr. T. V. Holmes:—

Gravel	30	180 feet
Chalk	150	

8. East Greenwich. Portland Cement Works. 1869.

Communicated by Messrs. Hollick & Co.
A Norton tube-well: on the wharf, about 20 feet from the Thames.

		Ft.
Made earth	... ...	16
[Alluvium]	Mud	35 to 40
	Black soft sand	8 or 10
	To hard stone	65

9. North Greenwich.

Boring, communicated by Dr. J. C. Thresh.
Yield 11,000 gallons an hour. Water brackish (see p. 313).

Superficial deposits	62	262 feet
Chalk	200	

10. Riverside Works, Blackwall Lane. Messrs. Redpath, Brown & Co.

A set of eleven shallow wells, 6 feet in diameter.
Made and communicated by Messrs. Isler & Co.

No. 1. Water-level 21 feet down.

Made up ground		15	23 feet
[Alluvium]	Light-blue clay	7	
[River Drift]	Gravel ...	1	

		No. 2. Thickness.	No. 2. Depth.	No. 3. Thickness.	No. 3. Depth.
		Ft.	Ft.	Ft.	Ft.
Made up ground		12	12	12	12
[Alluvium]	Light-blue clay	3	15	3	15
	Peat	2	17	1	16
	Light-blue clay	4	21	7	23
[River Drift]	Light-coloured sand* ...	3	24	1	24
	Gravel ...	½	24½	½	24½

* It is questionable whether this sand, which occurs in all but No. 1, does not belong to the Alluvium.

Water-level 21½ feet down in No. 2, 7 in No. 3.

No. 4.

Made up ground		12	22 feet
[Alluvium]	Blue clay	8	
	Peat	1	
[? River Drift]	Light-coloured sand	1	

		No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.
		Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
Made up ground... ...		12	12	12	12	12	12	12
[Alluvium]	Blue clay...	6	6	6	7	4	7	6
	Peat ...	2	2	2	1	3	1½	1
	Blue clay...	3½	1½	2½	1½	2½	½	3
[River Drift ?] Light-coloured sand ...		½	½	½	½	1	1	1
Total ...		24	22	23	22	22½	22	23

Hadlow.

Ordn. Map 287, new ser.; Geol. Map 6.

1. Frith Estate. New Lodge.

From a privately printed Report by Mr. J. Lucas, December 23rd, 1885.

		Thickness.	
		Ft.	in.
All Weald Clay, about 25 feet.	Shaly clay	10	0
	Sandstone	1	6
	Shale	1	6
	Stone	1	6
	Shale	1	0
	Stone	3	0
	Blue clay	1	0
	Light-coloured clay (probably marl)	2	0
	Blue clay, with an inch of ironstone at the bottom	1	1
	Light-coloured clay (probably marl)	1	6
	Blue clay	1	0

2. Style's Place Brewery. Nearly a mile S.S.E. of the Castle.

Communicated by Mr. E. Easton.
88 feet above Ordnance Datum. Bored throughout.
Water overflowed 24 feet above ground (at the rate of 40 gallons a minute, according to Mr. R. Batchelor).

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Drift]	Gravel	6	9	6	9
	Sand	4	0	10	9
[Weald Clay]	Atherfield clay [not so well down in the Weald Clay]. ? with 9 inches of rock at the base...	20	9	31	6
	Weald clay	138	6	170	0
	Limestone-rock	7	8	177	8
	Little water. Weald clay. ? rock at base	27	4	205	0
	Clay	94	7	299	7
[? Upper Tunbridge Wells Sand]	Rock	50	0	349	7
[? Grinstead Clay]	Mottled clay	35	0	384	7
	Red clay	14	0	398	7
[? Lower Tunbridge Wells Sand]	Very hard rock	56	6	455	1
	Clay	6	0	441	1
	Rock	59	6	500	7
[? Wadhurst]	Clay, with seven thin layers of rock	?127	0	627	7
[? Ashdown Beds]	Very hard rock	107	3	734	10
	Clay and black sand	2	9	737	7
	Sand. No water	5	0	742	7
	Rock	62	0	804	7
	Sand and petrified wood	5	0	809	7
	Sand	4	6	814	1
	Hard rocky sand	3	3	817	4
	Sand	1	6	818	10
	Hard clay	3	0	821	10
	Coarse sand	8	3	830	1

Mr. Batchelor says that the total depth is 838½ feet.
The classification given is doubtful.

Halstead. Public well, for the Sevenoaks Rural Sanitary Authority, about a quarter of a mile E.S.E. of the Church.

Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4 (new).
Made and communicated by Messrs. LE GRAND and SUTCLIFFE, with additional particulars from Dr. BAYLIS.
Shaft 19 feet, the rest bored. Yield 1,700 gallons a day.

Red loam and flints	19	384 feet
Chalk and flints ...	365	

Halling, *see* Lower Halling.

Ham Street (or Orlestone).

Ordn. Map 305, new ser.; Geol. Map 4.
150 feet deep. From Mr. H. CHESTERMAN through Mr. C. J. GILBERT. 1903.

Great wash-up of the surface, forming many sorts of soil, 50 feet.
At 65 feet, great quantity of gas from borehole.
At about 70 feet, some hard oak, partly carbonised.
At 74 feet, 2½ inches of coal, soft.
At 110 feet, about 4½ inches of hard bright coal: had to use rock-drill to pierce it.
12 feet of Gault [clay] bored through.
At 122 feet, about 4 inches of coal, bright and hard.

Hartlip. NEW PLACE. [? PLACE HOUSE.]

Ordn. Map 272, new ser.; Geol. Map 6.
W. BLAND. *Phil. Mag.*, 1832, new ser., vol. xi., p. 86, etc.
About 157 feet above sea-level. Depth to water about 130 feet. 140 feet deep; but deepened since.

The monthly variation in the depth of the water from January, 1819, to June, 1831, ranged from 5 feet 10 inches, in November and December, 1820, and December, 1821, to 20 feet 4 inches in April, 1825, in which last year it was not less than 11 feet 6 inches (in December). See also p. 5.

Harty (SHEPPEY).

Ordn. Map 273, new ser.; Geol. Map 3.

1. ELLIOTT'S HOUSE.

Dr. JAMES MITCHELL'S MSS., vol. iii., p. 233. Letter from Mr. S. BURNELL. (*S.E. Naturalist*, 1902.)

	Vegetable mould...	1	179 feet.
[London Clay]	Yellow clay ...	30	
	Blue clay, to sand	148	

2. SAYES COURT. Same authority.

	Thickness.	Depth.
	Ft.	Ft.
Vegetable mould	1	1
Yellow clay	4 or 5	6
Gravel	2	8
Blue [London] clay, to sand, about	170	178

Harty Ferry, *see* **Oare**.

Hawkhurst.

Ordn. Map 304, new ser.; Geol. Map 5.

1. BABIES' CASTLE, on the eastern side of the road to Cranbrook, W. of Beal's Green. 1893.

? About 175 feet above Ordnance Datum.
Made and communicated by Messrs. DOCWRA.
Shaft 7¾ feet, the rest bored. Intended only as a trial-boring, but adopted for the permanent supply.

The boring was originally to 200 feet. Then a pump at 122 feet drew air in 10½ minutes, throwing at the rate of 36 gallons a minute. Pump lowered to 168 feet, and drew air, working at same rate, in an hour and 54 minutes. Normal level of water 77 feet. When the rock at 207 to 208 feet was passed through the water-level went down to 150 feet. On putting in the pump again air was not drawn in, the pump throwing at the rate of 14,000 gallons in 24 hours.

		Thickness.	Depth.
		Ft.	Ft.
Made ground	...	1½	1½
[Tunbridge Wells Sand]	Coloured [mottled] clay	4½	6
	Sand-rock	11	17
	Red marl	3	20
	Blue marl	7	27
	Hard red marl	2	29
	Sand-rock	1	30
[Wadhurst Clay, 201 feet]	Red marl	8	38
	Mottled clay	11	49
	Blue marl	3	52
	Mottled clay	61	113
	Hard blue marl	12	125
	Blue marl, with rock at 207 to 208 [? to sand]	106	231

2. BOARZELL. For Mr. G. T. Gregory.

From Mr. TOPLEY's notes.
294 feet above the sea [? Ordnance Datum.]

		Ft.
? Wadhurst Clay	Yellow clay	3
	Blue marl	50
	Shelly bed, soft and white sandy clay, thinly bedded	½

Vents in stone with water. Therefore probably into the top of the Ashdown Sand.

3. RAILWAY STATION, N.N.W. of Gill's Green. 1893.

Communicated by Mr. STEPHENS.
From floor of tank-house, 264 feet above Ordnance Datum.
Shaft 95 feet, the rest bored (9 inches diameter).
? Water-level 136 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Tunbridge Wells Sand	...	25	25
[Wadhurst Clay, 267 feet.]	Blue shale	25	50
	Red shale	19	69
	Blue shale	223	292
[Ashdown Sand]	Bands of very hard shale, with layers of sandy material between, in which the water lies	12	304

Some additional particulars of the boring (made and communicated by Messrs. ISLER & Co., 1890).
Lined with 185 feet of tubes, of 6 inches diameter, 15 feet down.
Water-level 120 feet down. Yield 1,080 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well [old]		--	100
[Wadhurst Clay]	Marl ...	5	105
	Shale ...	98	203
	Stone ... Grey rock	47¾	250¾
	Slate rock...	29¼	280

The thickness of 267 feet given to the Wadhurst Clay seems too great.

Herne.

Ordn. Map 273, new ser.; Geol. Map 3.

1. HERNE BAY. Mr. Hardiman's. 1904.

Bored and communicated by Messrs. ISLER & Co.
Lined with 40 feet of tubes, of 4 inches diameter, from 2 feet down.
Water-level 12 feet down. Yield 400 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		1½	1½
[LondonClay]	Yellow clay	4	5½
	Blue clay ...	29½	35
[Oldhaven Beds] Green sand		15	50

2. HERNE BAY WATERWORKS, Sharper's Hill (name not on the newer map), at the eastern end of the town.

Communicated (to Mr. HAWKINS) by the Chairman of the Waterworks Co.,
Shaft 131 feet, the rest bored.

		Thickness.	Depth.
		Ft.	Ft.
Gravel		7	7
[London Clay]	Yellow clay	26	33
	Blue clay...	105	138
[Oldhaven, Woolwich, and Thanet Beds] Sand		163	301

3. NEWER WORKS AT FORD. Three wells.

Made and communicated by Messrs. DOCWRA.
No. 1. Shaft and cylinders to 95 feet, the rest bored. Galleries at 71 feet.

		Thickness.	Depth.
		Ft.	Ft.
[Woolwich and Thanet Beds]	Sand	32	32
	Red loam	6	38
	Dark sand and shells	22	60
	Hard dark sand	5	65
	Sandy clay and sandy blue clay	44½	109½
	Flints	½	110
[Upper] Chalk		269	379

No. 2. (*S.E. Naturalist*, 1902.) Shaft and cylinders 170½ feet, with galleries at 66 and 71 feet, the rest bored.
Water blew in at 167½ feet down.
Water-level 26 feet down. Yield, May 26th, 1891, 183,600 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
	Made ground	4	4
	[Woolwich, ? part Thanet, Beds] Sand	18	22
[Thanet Beds, 87 feet]	Red loam and sand	13	35
	Dark hard sand and shells	28	63
	Hard sand-rock	4	67
	Hard sandy clay, the greater part blue, with water	41	108
	Flints	1	109
	Chalk	? 61½	? 170½

Gallery connecting these two wells, with its base at 156½ feet.

No. 3. 1899 ? Galleries, with base 156 feet down, by Messrs. Doowra, not the rest.
Water-level 90 feet down when pumping.

		Thickness.	Depth.
		Ft.	Ft.
	Soil, a little...	—	—
[Woolwich and Thanet Beds]	Sand and red loamy sand	—	35
	Dark sand and shells	28	63
	Hard sandy rock	5	68
	Hard sandy clay	41	109
	Flints	1	110
	Chalk and flints	64	174

In *The Engineer*, vol. lxix., p. 442 (1890), one of the borings is said to go to the depth of 576 feet. As it yielded very little water it was decided to fire a series of charges of roburite. The first of these, of 27 lbs., was fired at the bottom; the second, of 25 lbs., was fired 50 feet higher, and this latter added 50,000 gallons a day to the yield.

The headings have been deepened to 11 feet below Ordnance Datum, and others driven, about north and south, in all 135 feet. Pumping 9,000 gallons an hour for eight hours, the water-level was lowered 11 feet in the first two hours and then stood. It rose again in about two hours. Besides Herne Bay the following villages are in the area supplied:—Herne, Hoath and Reculver (Water Works Directory, 1907).

3. Herne Bay Gas Works, Beach Street.

20 feet of 7¼ inch guide-pipes, 9 feet from surface.
200 feet of 6 inch permanent pipes, 6 feet from surface.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Dug Well	—		20	0
	Blue [London] Clay	14	0	34	0
[Oldhaven Beds, over 19 feet.]	Grey Sandstone	15	0	49	0
	Green Sand and Shells	4	0	53	0
	Pebbles	0	2	53	2
	[Woolwich and Thanet Beds] Green Sand	47	10	101	0
[Thanet Beds]	Green Sand and Clay	10	0	111	0
	Grey Clay	7	0	118	0
	Grey Clay and Shells	3	0	121	0
	Grey Clay	59	0	180	0
	Rotten Sandstone	1	0	181	0
	Grey Clay	14	6	195	6
	Flints...	0	6	196	0
	[Upper] Chalk and Flints	204	0	400	0

Hever. The Castle, 1904.

Ordn. Map 287, new ser.; Geol. Map 6.
Bored and communicated by Messrs. Isler & Co.
Lined with 180 feet of tubes, of 10 inches diameter, from 2 feet down, and 200 feet, of 8 inches diameter (perforated), from 150 feet down.
Water-level 98 feet down. Yield 7,500 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Soil...		1	1
[Weald Clay]	Yellow clay and stones	22	23
	Blue clay and stones	40	63
[? Weald Clay or Tunbridge Wells Sand]	Blue stone	12	75
	Blue clay, with beds of stone	111	186
[? Tunbridge Wells Sand]	Sandstone, with beds of clay	169	355
[? Wadhurst Clay]	Mottled clay	18	373

It is difficult to classify the beds. Possibly the sandstone, &c., may belong to the Ashdown Beds and the clayey beds above may be Wadhurst Clay. The site is close to where a fault is shown on the map.

Higham. Higham and Hundred of Hoo Waterworks, about a quarter of a mile south-south-west of the Railway Station. 1892.

Ordn. Map 272, new ser.; Geol. Map 1, S.E.
Communicated by Mr. E. Easton. (*Rochester Naturalist*, 1901.)

Shaft, in Chalk, 160 feet, with headings about east and west, bottom 153 feet down. 30 feet of water. Pumping 6,000 gallons an hour (November, 1892), just kept the water down. Work not then finished.

High Hockley.

Made for, and communicated by, the Hon. A. McGarel Hogg. 1898?

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Weald Clay	Dug well	—		80	0
	Enlarging old borehole (blue clay)	—		91	0
	Blue marl	42	6	133	6
	Loamy sand	1	6	135	0
	Sandy marl	2	6	137	6
	Blue marl	11	0	148	6
	Sandstone	0	10	149	4
	Light-grey marl [to fine sand]	13	2	162	6

Hildenborough, *see* **Tunbridge.**

Hinxhill (for the supply of Willesborough), half a mile north-eastward of the Church. 1899.

Ordn. Map 289, new ser.; Geol. Map 3.
Made and communicated by Messrs. Tilley. (*S.E. Naturalist*, 1902.)

Shaft 50 feet, the rest bored. Water-level 24½ feet down (26 feet later, according to Mr. J. M. LAWFORD). Yield 60 to 70 gallons a minute (up to September, 1900).

		Thickness.	Depth.
		Ft.	Ft.
Soil	...	2	2
[Gault]	Gault [clay]...	53½	55½
	Rock and shells	1½	57
[? Folkestone Beds]	Green sand and pyrites	23½	80½
	Brown clay ...	6½	87
	Hard sand ...	8½	95½
	Rotten brown clay...	7½	103
[Folkestone Beds]	Hard dirty sand	7	110
	Light-coloured sand	11½	121½
	Hard dirty sand	20	141½
	Light-coloured sand	28½	170
	Hard dirty sand	10	180
[Sandgate Beds, 22 feet]	Hard black clay	2	182
	Brown mottled clay	4	186
	Black clay ...	16	202

Hither Green, *see* Lewisham.

Hoo.

Ordn. Map 272, new ser.; Geol. Map 6.

1. HOO FORT. 1865 or 1866.

Communicated by the WAR OFFICE. (*Rochester Naturalist*, 1901.)
Bored throughout.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 46 feet]	Soil, mostly filled in with concrete	12	12
	Loam and sand	26	38
	Clay ...	6	44
	Peat ...	2	46
[Valley Drift, 10½ feet]	Flints and sand	5	51
	Coarse sharp sand	5	56
	Flints, &c. ...	½	56½
[Thanet Beds]	Silt or loamy sand	53¾	110¼
[? Upper Chalk, 350 feet]	Chalk, with flints	245¾	356
	Chalk, without flints,* with a grey vein above the middle	105	461

* There is some doubt as to this division of the Chalk, as a note on the drawing says "no flints met with in the last 42 feet."

2. HOO POINT.

Boring made for and communicated by the WAR OFFICE.

	Thickness.	Depth.
	Ft.	Ft.
Concrete ...	10	10
Sand, pebbles, loam, &c. about	130	140
Chalk ...	48	188

Hunton.

Ordn. Map 288, new ser.; Geol. Map 5.
Dr. J. MITCHELL'S MSS. (in Libr. Geol. Soc.), vol. iii., p. 204.
Well through blue [Weald] clay. Several shells found. 350 feet.

Hythe. WATERWORKS, *see* Saltwood.

Ightham. Opposite Albert Cottage, north of the village.

Ordn. Map 287, new ser. Geol. Map 6.
Communicated by Miss M. A. BROOKE.
A good supply at first; but it soon failed.
Through Gault and Lower Greensand like that at Oldbury Hill, 100 feet.

Iwade.

Ordn. Map 272, new ser.; Geol. Map 6.

1. CHITNEY HILL, north-westward of the village.

Dr. J. MITCHELL'S MSS. (in Libr. Geol. Soc.), vol. iii., p. 230.
(*Rochester Naturalist*, 1901.)
Water rose to within 8 feet of the surface.
Through blue [London] clay, 284 feet.

2. KING'S FERRY. (From the Mainland to Sheppey; now a bridge).

PRESTWICH, *Quart. Journ. Geol. Soc.*, vol. x., p. 405.
London Clay to 200 feet.

Kemsing. Trial-boring for the SEVENOAKS WATER CO. 1903.

Ordn. Map 287, new ser.; Geol. Map 6.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
About 292 feet above Ordnance Datum.
Water-levels 38 feet down at 46 feet, 41 feet down at 250.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil.	Clay and flints	6	0	6	0
[Gault, 35 feet]	Blue clay and shells	19	0	25	0
	Blue sandy clay	8	0	33	0
	Green sand and blue clay	8	0	41	0
[Folkestone Beds, 116½ feet]	Green sandstone. Water from 41 to 46 feet	5	0	46	0
	Bands of hard and soft stone ...	24	0	70	0
	Yellow sandy clay and bands of stone	8	0	78	0
	Light-brown rock, hard	5	0	83	0
	Yellow sandy clay and bands of stone	8	0	91	0
	Running sand, yellow	17	0	108	0
	Red sand. Band of ironstone at bottom	23	6	131	6
	Running sand, yellow	8	6	140	0
	Mottled sandy clay, bands of sand and ironstone	15	3	155	3
	Sandstone, ferruginous	2	3	157	6
[Sandgate Beds, 7⅓ feet]	Brown sandy clay	5	4	162	10
	Brown sandstone	0	8	163	6
	Brown sandy clay	1	4	164	10
[Hythe Beds]	Bands of sandstone, rag and hassock	78	8	243	6
[Atherfield Clay]	Stiff bluish-brown clay. Specimens, from 244½ feet, pale brownish; from the bottom fine compacted (? clayey) dark sand	6	6	250	0

The following record of a hand-pumping trial has been communicated by Mr. A. F. Bowker (March, 1903), when the level of the water was 41 feet down :—

Lowered	8 feet	(to 49 feet)	when pumping	850	gallons an hour
„	9 „	(to 50 „)	„ „	870	„ „
„	10 „	(to 51 „)	„ „	900	„ „
„	13 „	(to 54 „)	„ „	1,100	„ „

Kenardington.

Ordn. Map 304 or 305, new ser. ; Geol. Map 4.
Communicated by Mr. H. Chesterman, through Mr. O. J. Gilbert.
About 90 feet of Gaulty soil, with 2½ inches of soft coal at 65 feet.

Kent Waterworks. Now **Metropolitan Water Board,** which *see.*

Keycoll Hill, *see* Bobbing.

King's Ferry, *see* Iwade.

Kingsnorth. TAYLOR FARM.

Ordn. Map 305, new ser. ; Geol. Map 3.
A small boring of 120 feet, all in [Weald] clay.

Knockholt.

Ordn. Map 287 new ser. ; Geol. Map 6.
Dr. J. Mitchell's MSS. (in Libr. Geol. Soc.), vol. i., p. 193.

In Chalk 350 feet. Wood at 300 feet. A cave 30 feet long, 12 broad and 18 high at 270 feet, with a stream of water.

Lamorbey (or Lamb Abbey), *see* Bexley.

Lee.

Ordn. Map 271, new ser. ; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).

1. GROVE PARK. New Workhouse. Trial-boring. 1899.

From Mr. T. Dinwiddy, Architect, through Mr. T. V. Holmes.

			Thickness.	Depth.
			Ft.	Ft.
Subsoil			2	2
Ballast			3	5
[London Clay ?]	London clay		13	18
	[Basement-bed]	Black pebbles & water	2	20
		Clay and shells	1	21
[Oldhaven Beds ?]	Green sand and water		7	28
	Hard shells		2	30
	Green blowing sand		10	40
[Woolwich Beds]	Clay and shells		3	43
	Blowing sand and water		6	49
	Clay and shells		2	51
	Very hard clay and shells		9	60
	Coloured [mottled] clay		10	70
	Green sand, pebbles and water		10	80
	Black sand, pebbles and water		7	87
[Thanet Sand]	Very hard grey sand rock and water		8	95
	Live grey sand and water		45	140
	Flints		2	142
Chalk			101	243

In *Proc. Geol. Assoc.*, vol. xvi., part 10, p. 523, T. V. Holmes classifies from 18 to 40 feet down as Oldhaven. This may be right.

2. STEAM LAUNDRY (Miss Austin's). 1905.

Bored and communicated by Messrs. ISLER & Co.
Lined with 115 feet of tubes, of 5 inches diameter, level with the surface.
Water-level 17 feet down. Yield 3,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		4	4
[River Gravel] Ballast...		5	9
[? Woolwich Beds]	Mottled clay ...	4	13
	Running sand ...	10	23
	Sandy clay ...	14	37
	Sandy clay and shale [fissile clay]	13	50
	Mottled clay ...	4	54
	Green loamy sand ...	14	68
[Thanet Sand, 45 feet]	Running grey sand ...	44½	112½
	Flints ...	½	113
[Upper] Chalk and flints		87	200

Under Woolwich Beds some Oldhaven Beds may be included, and the top clay may possibly be London Clay.

3. STEAM LAUNDRY, High Road (Mr. Bray's). 1905.

Bored and communicated by Messrs. ISLER & Co.
Lined with 55 feet of tubes, of 4 inches diameter, from 3 feet down.
Water-level 10½ feet down. Yield 750 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Sand	5	5
	Ballast [gravel]	6	11
[Thanet Sand]	Sand	29	40
	Sand and clay ...	6	46
[Upper Chalk]	Chalk	22	68
	Chalk and flints	25	93

4. MANOR WAY. REDCOT, in the garden. 1901.

Communicated by Mr. C. H. WILLIAMS.

	Ft.	in.	
Soil...	0	8	8 ft. 3 in.
Flint pebbles in sandy matrix...	1	8	
Sandy clay, nearly black, with decayed vegetation	1	10	
Stiff blue clay, full of mineralized wood	0	10	
Sand	2	9	
Flint pebbles in sandy matrix...	0	6	

Lewisham.

Ordn. Map 270, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).

1. BROCKLEY, Watney's Brewery, a few feet from the south-eastern wall of Deptford Cemetery. 1880.

Sunk and communicated by Messrs. LE GRAND and SUTCLIFF.
Bored throughout, but shaft to be sunk for about 40 feet.

Water stands 40 feet below the surface. The natural rise of the spring at 48½ feet deep was 570 gallons an hour, at 51½ feet 690 gallons, and at 54½ feet 810 gallons. Supply estimated at about 1,800 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[? London Clay or Drift]	Sandy clay	2½	2½
	Gravel	1½	4
[Woolwich and Reading Beds, 46 feet]	Red fine live sand	3	7
	Dark red sand...	1½	8½
	Yellow clay and shells	1½	10
	Yellow clay	½	10½
	Shells	1	11½
	Red live sand	2½	14
	Sandy clay	1½	15½
	Blue clay	5	20½
	Sandy clay	9	29½
	Blue clay and shells	2½	32
	Shell-rock	3	35
	Light-blue and yellow clay... ...	3	38
	Light-grey loamy sand and black pebbles	6	44
	Green sand and clay and brown pebbles	6	50
[Thanet Sand, 49 feet]	Grey live sand	38	88
	Blue dead sand	11	99
Chalk and flints. The first 70 feet without water. Some supply at 250 feet down, which gradually increased to 320 feet		221	320

2. Hither Green, Park Hospital. 1897.

Communicated by Mr. E. T. Hall.

Shaft 94 feet, then two borings.

A little over 93 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Yellow clay	22	22
	Blue clay, with a thin water-bearing vein of sand at the depth of 41 feet	97	119
[? Blackheath Beds] Pebbles and sand. Water from this rose to within 45 feet of the surface ...		4½	123½
[Woolwich and Reading Beds, 61½ feet]	Dead sand	14	137½
	Clay and shells	15	152½
	Pebbles	7½	160
	Modeller's clay	6	166
	Red pebbles	8	174
	Green sand	11	185
[Thanet Sand, 47 feet]	Running sand...	29	214
	Dead sand	15	229
	Green flints	3	232
Chalk		—	—

The vein of sand in the London Clay yielded a sort of mineral water, with 189 grains of solids to the gallon (chiefly salt and sulphates of lime and magnesia), and with a hardness of 130°.

3. **Lower Sydenham**, Bell Green (this name does not appear on the new map), just south-south-west of Lower Sydenham Railway Station. Trial-boring, for the Lambeth Waterworks Co. 1882. On the western side of the railway, just southward of Lower Sydenham Station.

Communicated by Mr. J. Taylor, Engineer to the Company, and by Messrs. Docwra.

? About 90 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Mould ...	... ...	1	1
[London Clay, 92 feet]	Yellow clay	19	20
	Blue clay	10	30
	Blue clay of a lighter colour, with a foot of claystone at bottom ...	11	41
	Blue clay	52½ or 52	93
[Blackheath Beds.]	Pebbles, from which water rose 70 feet	7	100
[Woolwich Beds, 46 feet]	Peat [lignite ?]*	3	103
	Dark sand*	5	108
	Shelly clay	3	111
	Dark blue clay	4	115
	Blue clay of a lighter colour ...	3	118
	Very light-blue clay	2	120
	Shelly marl	6	126
	Shells	6	132
	Yellow clay	8	140
	Pebbles	6	146
[Thanet Beds]	Green sand	59 or 60	206
	Flints	½	206½
Chalk ...	... ...	11 or 10½	217

* These may perhaps belong to the Blackheath rather than to the Woolwich Beds.

On the southern side of Southend Lane, just over a quarter of a mile east of Lower Sydenham Station, a well proved 57 feet of clay.

4. **Workhouse**, on the high road, south of St. Mary's Church. Well at the back of the building, for washing-purposes only. 1889.

Communicated by Mr. T. V. Holmes.

			Thickness.	Depth.
			Ft.	Ft.
River Gravel ...		... ...	12	12
Woolwich Beds		Clay	2	14
		Running sand	6¼	20¼
	Shell-beds, 9 feet	Cyrena-bed ...	2½	22¾
		Clay	2½	25¼
		Cyrena-bed ...	2½	27¾
		Clay	½	28¼
		Shells (*Cyrena* ?)	1	29¼
		Left off in "race."		

5. **Proposed New Brewery** (Watney's), south-east of Cemetery, one and a half miles from Waterworks well, Deptford.

J. Lucas, *Trans. Inst. Surv.*, vol. xiii., p. 171 (1881).

To flints 99 feet. Then Chalk, the first 20 feet without water. Some supply got 250 feet down, and this gradually increased to 320 feet, when the supply from all sources was 30 gallons a minute.

Linsted *or* Teynham.

Ordn. Map 272, new ser.; Geol. Map 3.
Made and communicated by Messrs. LE GRAND and SUTCLIFF.
Water-level 23 feet down.

Dug well (no record of beds)	36	74 feet
Chalk and flints	38	

Lower Halling.

Ordn. Map 272, new ser.; Geol. Map 6.

1. Mr. BURCHFIELD'S. 1886. [I think that this may be really in *Snodland.*]

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
(*Rochester Naturalist,* 1901.)
Water-level 14½ feet down (December).

Dug well [old] ...	15	142 feet
Gault	115	
Lower Greensand	12	

2. MID KENT WATERWORKS, in Chalk Pit, by School, about half a mile north-westward of the Church. 1890.

Communicated by Mr. W. RUSS and from specimens. (*Rochester Naturalist,* 1901.)

Water from the Lower Greensand rose to 24 feet above Ordnance Datum, and ran away through the chalk, flooding the pit and raising the water-level in the Chalk-wells of the neighbourhood many feet. This water is now tubed off from the Chalk.

Yield, from the Lower Greensand, 38,000 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil ...	... ...	2	0	2	0
[Lower Chalk]	Chalk. {Pale cream-coloured at 15 feet Greyish at 35. Paler grey at 50}...	138	0	140	0
	Rock [? nodule-bed]	0	9	140	9
[Gault, 212 feet]	Gault Clay. {Hard, pale grey, and decidedly calcareous at 200 feet}	211	0	351	9
	Nodules (dark greenish sand) ...	1	0	352	9
[Folkestone Beds, 24 feet]	Dark sand, dry	4	0	356	9
	Green sand, dry	4	0	360	9
	Hard rock	1	8	362	5
	Green sand, dry	4	0	366	5
	Very hard rock	1	6	367	11
	Green sand, full of water	9	0	376	11

Some "sand washed up from the bottom of the borehole" is buff, fine and sharp.

(Words in these brackets from an account by Mr. R. D. Batchelor). This differs slightly in ignoring the "very hard rock" near the bottom and making the "running sand" beneath 10 feet, and the total depth 376 feet 5 inches.

According to *The Engineer* of February 28th, 1890, the shaft is 50 feet deep (to Chalk-water-level, 12 feet above Ordnance Datum), the rest bored and lined (15 inches diameter). The Gault was hard in parts.

? Second well. 1898.

Made and communicated by Messrs. Isler & Co.
Lined with 300 feet of tubes, of 15 inches diameter, from 56 feet down; and with 52 feet, of 13½ inches diameter (perforated), from 340½ feet down.
Water-level 46 feet down. Yield 24,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Shaft (the rest bored)		—	56
[Lower Chalk]	Grey chalk	78½	134½
	Chalk rock	1½	136
	Grey chalk	2	138
[Gault, 225 feet]	Gault	219	357
	Stone and dead green sand	6	363
[Folkestone Beds, 35 feet]	Rock	1½	364½
	Dead green sand	3½	368
	Lower green sand	3½	371½
	Blowing green sand	26½	398

Yearly supply, domestic 250 million gallons; in bulk to other authorities, 50 millions. Highest day's supply 1½ millions, in July. (Water Works Directory, 1907).

3. Messrs. Weeks' Cement Works.

Made and communicated by Mr. R. D. Batchelor.
(*Rochester Naturalist*, 1901.)
A 15-inch boring in a large pond in a chalk hole. The pond is supplied with spring-water from the chalk.

		Thickness.	Depth.
		Ft.	Ft.
[Lower Chalk]	Very tough white chalk, little water	21	21
	White chalk	52	73
	White rock	2	75
	Soft white rock	6½	81½

Lower Sydenham, *see* Lewisham.

Luton, *see* Chatham.

Lydd.

Ordn. Map 321, new ser.; Geol. Map 4.

1. Holmston Range, for the War Office (Camp). 1886.

(*Quart. Journ. Geol. Soc.*, vol. xliii., pp. 204, 205.)
The details were given by Messrs. S. F. Baker & Sons, who carried out the work.
Boring of a foot diameter to 57 feet, of 6 inches to 133; ? the rest 4 inches.
Depth of water-tight bore-pipes 250 feet.

Water-level 9 feet down. The water near the surface was oily, salt and unpleasant. This was cut off by the pipes, and the water then got was much better. Yield 90 gallons an hour. [This seems to refer to 1885, when the boring was only about 270 feet deep.] Finally this supply was abandoned as being too salt, and water is now got from a shallow well at the junction of the shingle and the marsh, about a third of a mile east of south from Dengemarsh Farm.

		Thickness		Depth.	
		Ft.	in.	Ft.	in.
? Recent Beds	Shingle	15	0	15	0
	Boulders	4	0	19	0
	Brown sand	13	0	32	0
	Clay, loam and sand	4	0	36	0
	Black or grey sand	20	0	56	0
	Pebbles	1	0	57	0
Hastings Beds	Black or grey sand	58	0	115	0
	Stiff loam	1	8	116	8
	Clean sharp sand	4	4	121	0
	Loamy clay	5	0	126	0
	Sand	2	0	128	0
	Clay	2	6	130	6
	Fine grey sand (water)	0	9	131	3
	Sandstone	2	3	133	6
	Clay and loam...	8	0	141	6
	Strong blue clay	5	6	147	0
	Stone	3	0	150	0
	White clay	20	6	170	6
	Marl	29	6	200	0
	Loamy clay	8	0	208	0
	Marl	42	0	250	0
	Hard stone	4	0	254	0
	Very hard stone	2	0	256	0
	Milder stone	2	0	258	0
	Tough clay	4	0	262	0
	Sandstone	1	0	263	0
	Stone	2	0	265	0
	Sandstone and clay	2	0	267	0
	Hard tough clay	2	0	269	0
	Very fine clay and stone	3	0	272	0
	Clay and stone	2	0	274	0
	Mild clay	3	0	277	0
	Very hard clay	12	0	289	0
	Veins of peat and clay	2	6	291	6
	Hard clay	1	6	293	0
	Very hard clay	2	6	295	6
	Mild sandstone, with water... ...	2	6	298	0
	Hard sandstone	4	0	302	0
	Mild clay	4	0	306	0
	Dark clay	31	0	337	0
	Red and white mild clay	6	0	343	0
	Hard light-coloured clay	7	0	350	0
	Hard red clay...	6	0	356	0
	Very hard dark clay	4	0	360	0
	Very mild dark clay	3	0	363	0
	Hard light-coloured clay	2	0	365	0
	Very hard dark brown stone or rock	3	0	368	0
	Hard sand rock, with water... ...	7	0	375	0
	Dark grey loamy soil...	4	0	379	0
	Very tough dark clay	13	6	392	6
	Very hard clay	10	0	402	6

A great number of specimens were examined, with Mr. Topley's assistance. They consisted mostly of pale greyish clays, with some light-coloured mottled clays, and a few very fine compact light-coloured sands, the whole being of like character to the beds that form the lower part of the Wealden Series, the bottom of which would probably be reached at no very great further depth. Some of the specimens are like some of those from the Dover Convict Prison boring.

Another account makes the stone below 147 feet 5 feet thick, the bed below 272, 6 feet, that below 289 feet 2, and the total 408.

2. PUBLIC SUPPLY.

Dr. W. W. E. FLETCHER'S Report to the Local Government Board upon . Romney Marsh Rural District, 1901, p. 13.

Six public pumps, on The Ripe, open ground S.E., S. and S.W. of the town. Against the western wall of the churchyard another, supplied from a well said to be under the roadway about 20 yards off. A short distance east of the churchyard, by the road to the station, is another (condemned).

The public wells on The Ripe are 18 feet or 20 feet deep; all steined with dry bricks only, except one, which is cemented half way down from the top. "The wells are mostly at a considerable distance from dwellings, and, though they are undoubtedly fed by subsoil water from the gravel [shingle], the water they furnish may be of a satisfactory character. On the other hand if the flow of the subsoil water be, as stated, from east to west, some of them may intercept water which has flowed under the town."

"Not a few of the inhabitants obtain water from private wells, and these are frequently so placed as justly to come under suspicion, indeed, the water from some is admittedly unfit for drinking or cooking purposes."

3. BREWERY AND MINERAL WATER WORKS. (Same authority) p. 14.

Two wells N. of the brewery and some way from buildings, 22½ feet deep, connected by a pipe. One lined with iron tubing 4 feet in diameter, the other a lined borehole of 10 inches diameter. Daily consumption 9,000 gallons. Water very hard.

Lydden. In the bottom of the valley five-sixths of a mile south-westward of the Church. For the Folkestone Waterworks Co.

Ordn. Map 289, new ser.; Geol. Map 3.
Communicated by Mr. H. TURNER, Engineer to the Company.

Shaft 185 feet [in Chalk], with very little water. As plenty of water has been got at the works in Capel-le-Ferne (see p. 97) this station has not been developed.

Maidstone.

Ordn. Map 288, new ser.; Geol. Map 6.
1—5. From Dr. J. MITCHELL'S MSS. (in *Libr. Geol. Soc.*), vol. iii., pp. 200, 201, 203? (*Rochester Naturalist*, 1901.)

1. Brenchley's Brewery.

Shaft 100 feet, the rest bored. Water rose to within 6 feet of the top. Supply abundant.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Gravel	7	7
[Weald Clay]	Blue clay	100	107
	Sand	2	109
	Blue clay, with thin seam of red clay at 139 feet, to sand	60	169

According to Mr. F. Drew, *Quart. Journ. Geol. Soc.*, vol. xvii., p. 273 (1861), " A boring at Brenchley's Brewery, at the bottom of Gabriel's Hill . . . . which began about at the top of the Weald Clay, went through 500 feet of clay (passing a water-bearing sand at 100 feet), and did not reach the bottom " of that clay.

2. Coach Yard, opposite the Star Inn.

Gravel ... ... 8 } 138 feet
Blue [Weald] clay, to sand 130 }

3. Near the Old Church.

Gravel ... ... 8 } 120 feet
Blue [Weald] clay 112 }

4. Ramcross, near the Old Church.

[Weald Clay] { Blue clay 110 } 121 feet
Sand ... 11 }

5. County Asylum, by the eastern edge of Barming Heath.

Ragstone and Green Sandstone, to Blue Clay, 100 feet.

Also " Below the Bridge (Maidstone) is a well which flows over " [but probably it has long ceased to do so].

6. Foley House, more than a mile north-eastward of All Saints' Church. Mr. J. Arkcoll's. Begun 1887 ?

Communicated by Mr. C. Bird from an examination of specimens taken at intervals of 5 feet in the boring. (*Rochester Naturalist*, 1901.)

		Depth. Ft.
Old Well [Folkestone Beds, Sandgate Beds, and Hythe Beds], the rest bored ...		164
1 to 57 (in the bore), no specimens ...		221
[? Weald Clay]	57 to 200. Dark clay ...	364
	203 to 223. Gritty ...	387
	228 to 233. Clay ...	397
	238. Red clay ...	402
	238 to 278. Clay ...	442
	283 to 289. Gritty ...	453
	293 to 298. Greyish clay...	462
	303 to 553. Clay, slightly gritty occasionally	717
	558. Lignite ...	722
	To 573. Dark clay...	737
	603. Grey mottled clay ...	767
	608. Red mottled clay ...	772
	613 to 623. Clay ...	787
	628 to 633. Gritty...	797
	638. Mottled [clay ?] ...	802
	643. Mottled [clay ?] ...	812
	653 to 778. Clay ...	942
[Hastings Beds]	783 to 848. Gritty (more or less) ...	1,012
	853 to 893. Gritty (about 20 per cent. of sand)	1,057
	898. Lignite and clay ...	1,062
	903 to 918. Sandy...	1,082
	923 to 928. Clay ...	1,092

Practically no water was got, and, from difficulties in boring, the work was abandoned. The diameter of the bore only 3 inches.

The specimens were all smashed up. As they had been pounded into mud, brought up, and dried, they were very much more alike than one would like to see them.

Afterwards a gallery about 180 feet long was driven, and 1,200 gallons in 24 hours got.

7. Medway Mills.

? About 20 feet above Ordnance Datum.
From Messrs. W. and R. Balston. {Notes of specimens by A. Strahan and W. Whitaker.}
Water at about 125 feet. It contains 16·5 grains per gallon of sodium-carbonate. Yield 9,000 gallons an hour.

	Thickness.	Depth.
	Ft.	Ft.
Yellow clay	11 or 12	--
Stone and yellow clay mixed {? fallen piece of L.G.S. stone}	3 or 4	15
Blue clay {greenish}. Metal nugget [pyrites] 100 feet down	110	125
Stone {very fine light-coloured sand}	1½	126½
Blue clay {greenish, as above}	14	140½
Red clay	9½	150
Blue clay {greenish, as above}, with about 6 inches of stone {slightly harder, sandy clay}	9½	159½
Blue clay {much as above}	40½	200

Mr. Strahan says that the whole seems to be Weald Clay, except the first two, which may be Drift or Rainwash.

A section communicated by Mr. James, late Curator of the Maidstone Museum, and purporting to refer to Springfield Mill, about a quarter of a mile higher up the river, is clearly the same as the above, and presumably has been wrongly named.

8. Milton Street. Mr. Hayward's. 1898.

Boring deepened and communicated by Messrs. Isler & Co.
Lined with 50 feet of tubes, of 4 inches diameter, from 3 feet down.
Water-level 49 feet down. Yield 400 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
	Rock... ...	15½	15½
	(Undescribed)	33½	49
[Weald Clay]	Sandy clay ...	20	69
	Blue clay ...	13	82
	Brown clay...	5	87
	Blue clay ...	9	96

9. South Eastern Railway Station.

Information from the Company to Sir J. Prestwich, 1856.

Blue clay, without water to 68 feet, but at that depth water immediately showed and rose in the borehole 50 feet.

Maidstone Waterworks.

The Maidstone Works (see also pp. 65, 88) supply Barming, Boxley, East and West Farleigh, and Loose. The yearly supply is 280 million gallons. (Water Works Directory, 1907.)

Marden. Royal Oak. Messrs. Jude, Hanbury & Co. 1895.

Ordn. Map 288, new ser.; Geol. Map 6.

Boring, of 4 inches diameter, made and communicated by Messrs. Isler & Co. Lined with 100 feet of tubes of 4 inches diameter, and 252 feet of 2½ inches diameter (bottom 20 feet perforated), the top of the latter 102½ feet down.

Water tapped at the depth of 351 feet, and rose 5 feet above the surface. Overflow 1,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[? All Weald Clay]	Blue clay	210½	210½
	Brown clay	5	215½
	Blue clay	123½	339
	Brown clay	3	342
	Brown clay and white sand, with water...	10	352
	Brown clay	2	354
	Blue clay	1	355

Margate.

Ordn. Map 274, new ser.; Geol. Map 3.

1. Messrs. Cobb's Brewery. 1869.

From specimens and information. A shorter account has been published by Mr. Dowker in *Geol. Mag.*, 1870, vol. vii., p. 467.
Shaft about 31 feet, the rest bored.

	Thickness.	Depth.
	Ft.	Ft.
[? Margate Chalk in shaft]	31	31
Chalk with flints [? Broadstairs and St. Margaret's Chalk]	265	296
Chalk without flints (? rocky)...	19	315
Grey clayey chalk	3	318
Chalk with bits of flint, 25 and 27 feet down Chalk with grey clay, 29 feet down ... ... Chalk with grey chalky clay that had to be dug out of the auger, 33 feet down ... ... Chalk with a little clay, 41 feet down ... Chalk with a little clay, hard nodules, and flints, 45 feet down ... ... Chalk, pasty and wet at bottom	56	374

According to Mr. B. Latham (*Trans. Soc. Eng.* for 1864, p. 244), a well at Margate, 50 feet in Chalk, yielded 200,000 gallons a day.

2. Waterworks.

The oldest works are at the Tivoli site, in the sharp angle between railway and road just N.E. of the Tivoli Gardens, and on low ground.

They consist of a shaft and galleries with floor 4 feet below Ordnance Datum, and 21 holes bored 20 feet lower.

A large supply has been got here; but the water gradually got worse in quality, by infiltration from the sea (which is probably made easy by the gravel beneath the Alluvium of The Brooks, as the narrow tract of marsh from here to the sea is called) and from other causes (cess-pits, etc.). Analyses from 1858 to 1886 showed this process of deterioration, and in 1874 the water was condemned by Dr. Letheby as unfit for domestic use. (See Analyses, pp. 325-328.) This Pumping Station is now abandoned.

The Company, in whose hands the supply originally was, afterwards established the Windmill Pumping Station, on higher ground southward of the town, nearly three-quarters of a mile eastward of the Tivoli site. This is a smaller work, also consisting of a well and galleries.

The Corporation has since made the Dane Works, but a little E.N.E. of the last at a little over 50 feet above Ordnance Datum. These consist of a well with a good length of headings, one of which connects with the Windmill Works and then turns south-eastward. The chief heading runs south-eastward from the former (near the well) roughly in the direction of the road, and has two short branches.

All the newer headings (at the Dane Station) are carried to 13 feet below Ordnance Datum, which is about 15 feet lower than the older headings at the Windmill Station, from which no water is got (1898).

In 1899 an experimental deep boring was made here by Messrs. Isler & Co., who have given the following particulars (*S.E. Naturalist*, 1902) :—

Lined with 12 feet of tubes, of 14 inches diameter, 15 feet 4 inches down ; with 100 feet of tubes, of 12 inches diameter, 12 feet 4 inches down ; with 260 feet of tubes, of 10 inches diameter, 55 feet down.

Water-level 61 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground	... ...	11½	11½
Loam ...	... ...	3½	15
[? Upper Chalk]	Hard chalk	5	20
	Chalk and flints	280	300
	Hard grey chalk and flints ...	39	339
[? Middle and Lower Chalk]	Grey chalk	226	565
	Hard grey chalk	148	713
	Hard dark clay	4	717
	Clay and stone [? nodule-bed]	2	719
[Gault]	Gault	57	776
	Hard green sand	6½	782½
[Lower Greensand]	Hard sandstone	12	794½
	Hard silt	14½	809
	Sand	41	850

Continued increase of pumping has caused some increase in the saltness of the water, and the Corporation has made large new works at a considerable distance, *see* Wingham.

The water-level in a well at Woodchurch Farm is said to have been affected by the pumping at the Tivoli Station, nearly two miles north-east. Mr. A. Latham says (1885) that there is no connection between the Tivoli and the Windmill sites ; the lowering of the water at the former had not the slightest effect on the water-level at the latter.

Martin. EAST KENT WATERWORKS, *see* **East Langdon.**

Matfield, *see* **Brenchley.**

Metropolitan Water Board, formerly KENT WATERWORKS Co., *see* **Beckenham, Bexley, Crayford, Darenth, Dartford, Deptford, Farnborough, Plumstead, Southfleet, Westerham, West Wickham, Wilmington.**

Mid Kent Waterworks, *see* **Charing** and **Lower Halling.**

Milton by Sittingbourne, *see* **Murston.**

Minster (SHEPPEY).

Ordn. Map 272, new ser.; Geol. Maps 2, 3.

1. RUSHENDEN HILL (a mile S.W. from Queenborough Church). For the Queenborough Town Council. Boring.

From Mr. H. SMALL, Borough Engineer, through the Local Government Board.

65 feet above Ordnance Datum.

Yield 3,000 to 3,500 gallons an hour, with continuous pumping for 21 days.

Level of water at beginning of pumping 31 feet below Ordnance Datum, at cessation of pumping 185 feet. Water returns to original rest-level, after pumping has ceased, in 30 minutes.

		Thickness.	Depth.
		Ft.	Ft.
[London] Clay ...		300	300
[? Oldhaven, Woolwich, and Thanet Beds]	Thanet Sand [not so]	30	330
	Very fine sand... ...	70	400
Chalk ...		1	401

2. SOUTH LEES FARM, Crown Lands. Less than 1½ miles S. of the Church. 1904.

Communicated by Messrs. BARNES and SHARPE, of Sleaford.

Water got in the green sand at 284 feet. Water-level 50 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Dark blue clay, with claystone-boulder [septaria], a foot at the base ...	81	81
	Brown clay, with claystone-boulder [septaria], a foot at the base ...	105	186
	Dark blue clay ...	93	279
[Oldhaven Beds and Woolwich Beds]	Green sand ...	14	293
	Sand ...	1	294
	Black sand ...	23	317
	Green sand ...	19	336
[Woolwich Beds and Thanet Beds]	Blue clay ...	4	340
	Green sand ...	78	418
	Light-blue clay ...	41	459
Chalk ...		18	477

3. NEATSCOURT MARSHES, Crown Lands. Against two cottages about 1½ miles north of Kingsbridge (over the Swale) and on the southern side of the road from Queenborough to Eastchurch. 1904?

Made and communicated by Messrs. BARNES and SHARPE, of Sleaford.

Water-level 40 feet down. Fair supply of good water.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Soil	2	2
	Soft silty soil ...	15	17
[London Clay]	Brown clay ...	50	67
	Blue clay... ...	143	210
[? Oldhaven Beds]	Sand and water	11	221

THIRD WELL (No. 2 Boring of Messrs. Isler). 1904.

Made and communicated by Messrs. ISLER & Co.
Lined with 187½ feet of tubes, of 8½ inches diameter, from 8 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium] Brown clay and stones ...		3	3
[? Alluvium and London Clay] Blue clay...		27	30
[Lower London Tertiaries]	Dead green sand and shells	8	38
	Dead black sand and shells	10	48
	Green sand	130	178
[Upper] Chalk		122	300

FOURTH WELL (No. 3 Boring of Messrs. Isler). 1905.

Made and communicated by Messrs. ISLER & Co.
Lined with 210 feet of tubes, of 11½ inches diameter, level with the surface.
Water overflows.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Brown clay	4	4
	Black mud	30	34
[? Oldhaven Beds]	Mud and shells ...	5	39
	Ballast [? flint pebbles]	4	43
[Woolwich Beds and Thanet Beds]	Sand and shells ...	5	48
	Green sand	141	189
[Upper Chalk]	White chalk	135	324
	White and grey chalk	26	350

5. HARTY FERRY. Mining Machinery and Improvements Co. 1900.

Boring, of 8 inches diameter, made and communicated by Mr. R. D. BATCHELOR. (*S.E. Naturalist*, 1902.)

		Thickness.	Depth.
		Ft.	Ft.
Well (old), the rest bored ...		—	13
London Clay		32	45
[Oldhaven, Woolwich, & Thanet Beds]	Sand and clay	11	56
	Green sand ...	12	68
	Sand	116	184
Chalk and flint		68	252

The depth to the Chalk is given as 182, and the total depth as 250.

Orlestone, *see* **Ham Street.**

Orpington. Cockmannings, nearly a mile N. of E. from the Church.

Ordn. Map 271, new ser.; Geol. Map 6.
Communicated by Dr. J. C. THRESH (from Mr. POWELL, Inspector, St. Mary Cray).
Sunk 150 years ago (= about 1750), and failed in the summer of 1898 for the first time.
85 feet deep. Contains only a few feet of water.
[Must be through Thanet Sand to Chalk.]

Orpington, Pumping Station, *see* **Farnborough.**

Otford.

Ordn. Map 287, new ser.; Geol. Map 6.

1. For the Rural Sanitary Authority [now Sevenoaks Rural District Council]. Just N. of Longford Mill, Dunton Green, 1887.

Made and communicated by Messrs. TILLEY, with further information from Mr. T. HENNELL.

About 235 feet above Ordnance Datum.

Floor-level 2 feet below natural ground. Shaft 19 feet, the bottom 2 feet filled with concrete.

A boring of 8½ feet, another of 17, and another to the depth of 92.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		4	4
[Gault, 34 feet]	Gault [clay]	31	35
	Green sand	3	38
[Folkestone Beds]	Loose dark sand ...	10	48
	Loose light-yellow sand	22	70
	Hard sand	9	79
	White sand	4	83

When first sunk, and before the bottom was put in the well, a supply of 56 to 58 gallons a minute was got. In 1896 about 45, whereof 12 only were from the deep boring and 33 from the short pipe; nothing from the 17 feet pipe, which was entirely blocked by sand. From a boring about 20 yards from the well a small supply was previously got at 25 feet and a much better one from a boring to about 80 feet, where there seemed to be a hard crust, which was not found below the well.

Water stands about 9½ feet down in the well after a rest of a few days. According to information on the spot (Feb., 1896), the water rises to about 12 feet from the surface and is lowered 8 feet by pumping (15 hours a day), the supply being about 20,000 gallons a day.

It is not a little singular that at the time of my visit these very small works should have had three separate motive powers: gas, steam, and electricity.

2. "A little north-west of Longford Mill a well was sunk in Gault Clay for 90 feet, and at that depth reached the Lower Greensand . . . on reaching the sand, water rose to within 35 feet of the surface." TOPLEY, "Geology of the Weald," p. 148.

3. DUNTON GREEN BRICKWORKS, by the eastern side of the railway, about a third of a mile south of the Station.

From information on the spot, 1902.

Shaft about 51 feet, then 15 feet of boring, of 6 inches diameter.

Through clay [Gault], sandy at the base, to rock, in which water was found. It rises to 34 feet below the surface and is lowered only about 2 feet by 24 hours' pumping. It seems to be good water.

4. MR. FREEMAN'S WELL. ? In the village.

Communicated by Mr. FREEMAN.

190 feet above Ordnance Datum.

In 1898 water overflowed steadily (Feb.). In April (? another well) the water-bearing bed (Lower Greensand) was reached at the depth of 301 feet, and a yield of 16,000 gallons an hour resulted. (*S.E. Gazette*, 5th April, 1898.) Shaft 100 feet, boring 201.

5. Little Dunton, about a mile W.S.W. of the village.

J. Lucas. *Trans. Inst. Surveyors*, 1877, vol. ix., p. 177.
Well about 295 feet above Ordnance Datum, 49¼ feet deep, 34¾ to water.
In Upper Greensand.

Pembury.

Ordn. Maps 287, 303, new ser.; Geol. Map 6.

In the Memoir "On the Geology of the Weald," Mr. Topley alludes to a well at Pellat Gate (or Kenwards), as proving 160 feet of Wadhurst Clay (p. 73). In a Report on the Water Supply of Tunbridge Wells, 1894, p. 3, he adds that this old well was abandoned because the water was unfit for drinking purposes.

1. Tunbridge Workhouse. Abandoned in 1887.

Bench-mark at the place 393 feet above Ordnance Datum.
Communicated by Messrs. Le Grand and Sutcliff.

		Thickness.	Depth.
		Ft.	Ft.
Old well (about 108 feet) and boring, through Tunbridge Wells Sand into Wadhurst Clay		—	248
[Wadhurst Clay]	Blue stone	4¼	252¼
	Hard blue clay, with hard stone at 288¾ to 292¾...	54¾	307

2—5. Tunbridge Wells Waterworks.

"The water supply of the borough is derived from twelve deep-seated springs gravitating . . . to a large open storage reservoir . . . and is supplemented, when required, by an excellent water obtained from five deep artesian borings through the Wadhurst clay into the Ashdown sands."

"The daily supply fluctuates from about 700,000 gallons to 1,000,000 gallons . . . and the total yearly supply is about 260,000,000 gallons, equivalent to a total consumption of about 20 gallons per head per day, including that used for trade, garden, and municipal purposes."

"The . . . area of supply extends considerably beyond the borough boundaries." (*Proc. Inst. San. Eng.*, vol. viii., 1904, pp. 77, 78.)

Mr. W. H. Maxwell, the Waterworks Engineer of Tunbridge Wells, has given a general account of the works, from which the following is taken:—

The supply "is obtained from four bore-wells sunk to a depth of 350 feet, and of diameters varying from 11½ inches to 15 inches. . . The wells are lined with solid steel tubes through the clay, and with perforated steel tubes in the sands. An additional well has also been recently sunk about a mile to the north-east of Pembury" (400 feet deep).

"These borings show that the water in the Ashdown sands of this district is held down by a bed of clay some 200 feet thick, and that when the water-bearing stratum is reached . . the water at once rises to an approximate rest level of about 100 feet below the ground surface, and that it is thus tapped under an artesian head or pressure equal to about 100 feet, or 44 pounds to the square inch."

"The water-level in all the wells is approximately the same, and the quantities obtained from the comparatively small amount of surface exposed in the borings go to show that the sands must be of a very permeable nature, and that the percolation of rainfall at the 'outcrop' has well maintained the level of the underground supply." 32nd Ann. Rep. L.G.B. Supplement, p. 585 (1904).

No. 1. Borehole.

Made and communicated by Messrs. Isler & Co.
(Words in these brackets from a section by Mr. Maxwell, in the Report quoted above, and also the lowest four beds).

Lined with 200 feet of tubes, of 15 inches diameter, from 3 feet down.
„ 142 „ „ 13½ „ „ 196 „
„ 15 „ „ 11½ „ „ 346 „

Water-level 100 feet down. Supply 12,000 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Tunbridge Wells Sand]	Brown clay (filling in)	18	3	18	3
	Light-coloured sandy clay	5	1	23	4
	Brown (red) sandy clay	1	8	25	0
	Brown (and white) rock	6	0	31	0
	Light-coloured (white) sand-rock ...	5	0	36	0
[Wadhurst Clay, 168 feet]	Dark brown clay (mixed clays) ...	2	0	38	0
	Red and blue clay, mixed	4	0	42	0
	Dark blue clay	46	0	88	0
	Blue shaly rock (shale)	5	0	93	0
	(Light-coloured) blue clay	21	0	114	0
	Blue shaly rock (shale)	2	6	116	6
	Blue clay	56	0	172	6
	Hard shaly rock (shale)	1	6	174	0
	Blue clay	6	0	180	0
	Blue shaly rock (hard shale 1½ feet)	1	0	181	0
	Blue clay	13	0	194	0
	Blue shaly rock (hard shale 2 feet)	2	6	196	6
	Blue clay	6	0	202	6
	White sandy clay (clay and sand) ...	1	6	204	0
[Ashdown Beds, 146 feet]	Ashdown sand (dark grey sand-rock)	1	6	205	6
	Grey sandy rock	9	0	214	6
	White sand-rock (very hard) ...	11	6	226	0
	Brown (sand) rock with thin layers of clay	6	0	232	0
	White sand-rock (dark brown clay, top 8 inches)	8	0	240	0
	Brown (sand) rock with thin layers of clay	8	6	248	6
	Clay (light-coloured)...	2	0	250	6
	White sand-rock	20	6	271	0
	Sandy clay (light-coloured)... ...	8	0	279	0
	Sand-rock (white)	3	0	282	0
	Rock and clay...	3	0	285	0
	Sand-rock (white, hard)	9	6	294	6
	Clay and rock...	5	6	300	0
	Sand-rock (grey, hard)	9	6	309	6
	Soft brown rock	4	0	313	6
	Hard white (sand) rock	18	6	332	0
	Blue clay	6	0	338	0
	White (sand) rock	3	0	341	0
	Light-coloured clay	2	0	343	0
	Soft white sand	1	6	344	6
	White sand-rock	3	6	348	0
	Light-coloured clay	2	0	350	0

Boring No. 2. Bassett's Farm. 1902.

Over 204 feet above Ordnance Datum.

Made and communicated by Messrs. Isler & Co. (Words in brackets from Dr. G. Abbott).

Lined with 200 feet of tubes, of 15½ inches diameter, from the surface;

with 170 feet, of 13½ inches diameter, from 199 feet down; and with 32 feet of 11½ inches diameter, about 368 feet down.

Yield 20,000 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Mottled clay	1	0	1	0
	Sandstone	3	0	4	0
[Wadhurst Clay] ? 197¼ feet	Clay and stone (mixed)	7	0	11	0
	Blue clay	5	0	16	0
	Brown and red clay	5	0	21	0
	Blue clay and shale	1	0	22	0
	Blue shale	1	6	23	6
	Blue clay and shale, very hard	37	6	61	0
	Stone and grey rock	1	3	62	3
	Clay and shale	16	9	79	0
	Hard grey stone	4	9	83	9
	Hard blue shale	13	7	97	4
	Stone with shells	8	0	105	4
	Hard shale and shells	2	0	107	4
	Hard shale (shaly clay)	40	4	147	8
	Blue and greenish rock	1	0	148	8
	Hard greenish shale (shaly clay)	26	0	174	8
	Grey rock	1	6	176	2
	Hard shale (shaly clay)	13	6	189	8
	Very hard grey stone	1	0	190	8
	Hard shale (shaly clay)	10	7	201	3
[Ashdown Sand, 198¾ feet]	Sandstone	0	6	201	9
	Lighter-coloured sandstone (grey)	1	0	202	9
	Very hard sandstone (white)	13	4	216	1
	Light-coloured clay-stone (sandy clay)	7	2	223	3
	Sandstone (light-coloured)	26	9	250	0
	Dark shaly clay	2	0	252	0
	Light-coloured sandstone (white)	8	0	260	0
	Light-coloured shale (shaly clay)	2	0	262	0
	Brown (sand) rock	5	3	267	3
	Light-coloured shale (clay)	1	8	268	11
	Brownish rock (white and brown)	5	7	274	6
	Grey rock (fine)	8	0	282	6
	Light-grey rock (coarser)	7	0	289	6
	Brownish rock, mixed (coarse, brown and grey)	8	0	297	6
	Grey sandstone, fine (soft rock)	3	4	300	10
	Grey sandstone, coarse, with lignite	1	4	302	2
	White sandstone	1	8	303	10
	Rotten sandstone	9	0	312	10
	White sandstone	12	0	324	10
	Black seam (lignite)	0	4	325	2
	Shale and rock	6	0	331	2
	White (sand) rock	3	0	334	2
	Shale (dark)	1	0	335	2
	Brown (sand) rock	5	0	340	2
	White sandstone	22	0	362	2
	Brown (sand) rock	6	4	368	6
	White sandstone, rotten	8	3	376	9
	Grey stone	7	3	384	0
	Grey (sand) stone, very hard (white)	3	0	387	0
	White sandstone	3	0	390	0
	Grey sandstone	1	6	391	6
	White sandstone	5	0	396	6
	Sandstone	3	6	400	0

Borehole No. 3.

Nearly 199 feet above Ordnance Datum. Yield 20,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Wadhurst Clay]	Mixed clays	13	13
	Brown rock	4	17
	Yellow sand-rock	10	27
	Yellow clay	1½	28½
	Light-blue clay	5	33½
	Mixed clays	6½	40
	Dark blue clay	2	42
	Dark brown clay	3½	45½
	Dark blue clay	51½	97
	Dark blue shale	19	116
	Dark blue clay	88	204
[Ashdown Sands, 146 feet]	Sand	1½	205½
	White sand-rock, mixed with white spar in top, 6 feet	21	226½
	Light-grey rock	3½	230
	White sand-rock, with light-coloured clay at 237 to 237½ and 250½ to 252¼	40¼	270¼
	Brown sandy clay	8½	278¾
	White sandy rock, with brown clay at 284½ to 285	15¾	294½
	Blue clay	3½	298
	Brown rock	6	304
	White sand-rock	15	319
	Brown sand-rock	16½	335½
	Light-coloured clay	6½	342
	White sand-rock, with dark brown clay at 343½ to 345½	6½	348½
	Light-coloured clay	1½	350

The last two sections are notable for the great thickness of the Wadhurst Clay, much beyond that formerly estimated.

Borehole No. 4. ? 1895.

Nearly 199 feet above Ordnance Datum.
Made and communicated by Messrs. Isler & Co. 1898.

Lined with 180 feet of 11½ inch tubes, from 4 feet 8 inches down, and with 132 feet of 10 inch (internal) tubes, from 203 feet down, the bottom 80 feet perforated.

Water-level about 54 feet down. Supply, from two wells, between 25 and 30 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Well [? old]		—	—	10	0
Wadhurst Clay.	Blue marl	174	6	184	6
[Ashdown Sands, 150½ feet]	Hard grey sandy rock ...	43	6	228	0
	Bands of grey clay and rock	30	0	258	0
	Clay and rock Hard sandy rock	15	6	273	6
	Clay and rock	5	6	279	0
	Hard grey rock	6	3	285	3
	Sandy rock	3	9	289	0
	Hard clay	3	6	292	6
	Very hard rock	2	6	295	0
	Rock and clay	7	3	302	3
	Hard rock	5	2	307	5
	Clay and rock	1	0	308	5

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Rock...	5	0	313	5
[Ashdown Sands. 150½ feet]	Clay ...	4	0	317	5
	Clay and rock	7	7	325	0
	Clay ...	2	6	327	6
	Rock...	4	8	332	2
	Clay ...	2	10	335	0

Apparently the following account from Dr. G. ABBOTT of what he describes as well 1 refers to the above, as the depth to the base of the Wadhurst Clay and the total depth are the same :—

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Filling in...		—	--	20	0
Wadhurst Clay	Light-blue clay	8	0	28	0
	Darker blue clay	22	0	50	0
	Dark blue clay	4	0	54	0
	Light-blue shale and clay	12	0	66	0
	Light-blue clay	4	0	70	0
	Dark blue clay	11	0	81	0
	Dark blue shale and clay, lower half with sand	3	0	84	0
	Dark blue clay	25	0	109	0
	Light-blue clay	3	0	112	0
	Dark blue clay with shale	6	0	118	0
	Light-blue clay	12	0	130	0
	Light-blue clay with shale	24	0	154	0
	Very hard dark shale	1	0	155	0
	Light-blue clay	6	0	161	0
	Light-blue clay and shale	10	0	171	0
	Dark hard shale	2	0	173	0
	Dark blue clay	10	0	183	0
	Light-coloured sand and clay	1	6	184	6
Ashdown Sand, 150½ feet	Grey sand-rock	1	6	186	0
	White sand-rock	9	0	195	0
	Grey sand-rock	7	0	202	0
	Clay and rock mixed...	2	0	204	0
	Darkish sand-rock, with 6 inches of sandy clay at base...	9	0	213	0
	Light-coloured sandy clay ...	2	0	215	0
	Brownish sandy clay...	13	6	228	6
	Light-coloured sandy clay ...	10	6	239	0
	Brownish sandy clay...	18	0	257	0
	White sand-rock	2	0	259	0
	Darker rock ...	4	0	263	0
	White sand-rock	8	0	271	0
	Light-blue sandy clay	8	0	279	0
	White sand-rock	9	6	288	6
	Light-coloured sandy clay ...	4	0	292	6
	White sand-rock	2	0	294	6
	White sand-rock, softer	10	5	304	11
	White sand-rock, very hard	2	8	307	7
	Brownish clay...	0	6	308	1
	White soft rock	6	0	314	1
	Light-blue clay	4	4	318	5
	White sand-rock	1	7	320	0
	Brownish clay...	6	0	326	0
	Blue clay, top 16 inches light-coloured, the rest darker...	3	0	329	0
	White sand-rock	4	0	333	0
	Dark sandy clay	2	0	335	0

The following places are within the area of control of the Tunbridge Wells works:—Langton, Pembury, Southborough and Speldhurst, besides Frant, in Sussex. The quantity drawn in 1906 was, from springs 253,366,624 gallons, from wells and borings 113,510,862 (but the yearly supply is given as 300 millions). The highest day's consumption was 1,100,000. (Water Works Directory, 1907.)

Pluckley. Brickyard close to the railway, 200 yards W. of the Station.

Ordn. Map 288, new ser.; Geol. Map 3.
Communicated by Mr. W. TONGUE, of Woolwich (to W. Topley). 1878.
Water plentiful and overflowing.
[Weald] Clay; the bottom 4 feet a fine sandy bed.

Plumstead.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs and London District, Sheet 4.

1. BATHS.

A boring, with air-lift.
From a section by J. R. DIXON, Borough Engineer, Woolwich, 1907.

		Thickness.	Depth.
		Ft.	Ft.
Soil	... ...	1½	1½
[River Drift].	Gravel...	15½	17
[Thanet Beds]	Sand	10	27
	Sand and marl ...	7	34
[Upper Chalk]	Chalk and flints ...	88	122
	Hard chalk and flints	18	140
	Chalk and flints ...	137¾	277¾
	Grey chalk and flints	7½	285¼
	Chalk and flints ...	5	290¼
	Hard chalk and flints	41½	331¾
	Chalk and flints ...	43¼	375
	Very hard chalk ...	9	384
	Chalk and flints ...	8	392
	Hard chalk	20	412
	Chalk and flints ...	8	420

2. BOSTON [BOSTALL] HEATH, near Woolwich.

Trans. Geol. Soc., vol. iv., p. 291.

	Thickness.	Depth.
	Ft.	Ft.
Gravel [pebble-beds, Blackheath and Woolwich Series]	65	65
Sandy [Thanet] beds	65	130
Chalk	70	200

3. BREWERY.

Made and communicated by Messrs. DOCWRA.
Shaft 82 feet, with headings in the Chalk, at about 73 to 80.

Loamy clay and sandy loam 52 } 131 feet
Chalk... ... ... 79 }

4. PLUMSTEAD COMMON.

Trans. Geol. Soc., vol. iv., p. 290.

Gravel [pebble-beds, Blackheath and Woolwich Series] [Thanet] Sand	120	144 feet
Chalk...	24	

5. WATERWORKS (of the Metropolitan Water Board). 1854-7.

From the Engineer's Report (W. MORRIS) presented to the Metropolitan Water Board Arbitrators, 1903. The division of the Chalk from an older source.

About 80 feet above Ordnance Datum.

Three shafts about 135 feet, connected by headings, the bottom about 118 feet down in the pumping well; the other two wells with borings.

Normal water-level about 70 feet below the surface (according to Mr. S. C. HOMERSHAM, many years ago). On September 9th, 1903, when pumping was not going on, the water-level was about 78 feet down, and while pumping about 108 feet.

		Thickness.	Depth.
		Ft.	Ft.
[Blackheath Beds]	Pebble-bed ... ... about	10	10
[Woolwich Beds]	Sand and clay ... ... „	4½	14½
	Shell-bed ... ... „	6	20½
	Buff and greenish sand ... „	14½	35
[Thanet Beds]	White sand ... ... „	17½	52½
	Loam and sand, with flints at the base ... ... „	21½	74
Chalk, 563 feet	Chalk with flints	243½	317½
	Chalk without flints	319½	637

The total thickness is given as 632 feet, and in an older account the depth to Chalk is made 69.

6. WHITE HART LANE. Electric Lighting Station and Destructor, just N. of the railway. 1901.

From a tracing from Mr. F. SUMNER.

		Thickness.	Depth.
		Ft.	Ft.
Soil ...	... ...	½	½
[Alluvium]	Brown clay	4½	5
	Peat	3½	8½
	Silty sand	¼	8¾
[River Drift]	Dark ballast [gravel]...	3¼	12
	Red ballast and sand	3½	15½
	Rich ballast	21	36½
[Thanet Sand]	Bright sand	2½	39
	Grey sand	9½	48½
Chalk ...	... ...	—	—

Queenborough (SHEPPEY),

Ordn. Map 272, new ser.; Geol. Map 3.
Recorded in *Phil. Trans.*, vol. xxxvi., p. 191 (1730 ?).

Water found at a depth of 280 feet [? = the thickness of the London Clay], and rose nearly 180 feet (according to Dr. J. Mitchell's MSS., vol. iii., p. 227, to within 9 feet of the surface).

Rainham.

Ordn. Map 272, new ser.; Geol. Map 6.

1. Falcon Cement Works (Messrs. Burge and Barrow).

Made and communicated by Mr. R. D. Batchelor. (*Rochester Naturalist*, 1901.)

Shaft 36 feet, the rest bored (15½ inches diameter to the depth of 70 feet, the rest 12 inches).

30,000 gallons [? an hour] pumped continuously without affecting the yield.

		Thickness.	Depth.
		Ft.	Ft.
[? Drift and Thanet Beds]	Loam and sand	40	40
[Thanet Beds]	Dark sand and clay ...	24	64
	Flints	1	65
[Upper Chalk]	Chalk and flints	5	70
	Chalk	3	73
	Chalk and flints	69	142

2. Public Supply. Communicated by Mr. W. L. Grant.

Boring lined with tubes. Diameter at bottom, 5 inches. A good supply of excellent water.

Dr. Sweeting, in a Report to the Local Government Board (1901), says that from the sand "17,000 gallons an hour have on occasions been pumped. From the chalk some 8,000 gallons an hour have been obtained."

	Thickness.	Depth.
	Ft.	Ft.
Chalk	480	480
Marl and gault [includes some Chalk Marl]	398	878
Two thin layers of rock with sand between	8	886
Lower Greensand	20¾	906¾

Besides Rainham the following places are in the area supplied:—Hartlip, Lower Halstow, Newington and Upchurch. (Waterworks Directory, 1907.)

Ramsgate. Waterworks. 1835 and later.

Ordn. Map 274, new ser.; Geol. Map 3.

Information from Mr. W. A. Valon and Mr. T. N. Ritson.

Pumping station about a sixth of a mile east of Whitehall, on the western side of the road to Margate.

About 100 feet above Ordnance Datum.

Depth of pumping well, in Chalk, 120 feet. Three wells connected by headings.

Level of headings mean water-mark. In February 1887 the length of these was 1,600 yards, from E. to W. Since then they have been increased, and they run from the well irregularly N.N.E. to the borough-boundary beyond Newlands Grange, and very irregularly S.W. to St. Lawrence station and thence irregularly W.S.W. to nearly a third of a mile beyond Hollins Bottom (or north of Cliffsend). In all the length comes to more than 2⅓ miles.

The following figures of water-levels were given in 1887:—

Before pumping, 16 feet above mean water-level.
Lowest water-level in winter 10 feet above mean level.
" " summer 3 " " "

The northern end of the headings is between half and two-thirds of a mile from the Rumfield Pumping Station of Broadstairs.

Besides Ramsgate and St. Lawrence, Haine, Manston and Minster are within the area of control. The supply for the year ending March 1906 was:—For domestic purposes, 364,888,163 gallons; for trade-purposes, 33,602,412; for municipal purposes, 26,774,165, or a total of 424,764,770. (Waterworks Directory, 1907.)

Rochester.

Ordn. Map 272, new ser.; Geol. Map 6.

1. Borstal. Messrs. Booth & Co.

Made and communicated by Mr. R. D. Batchelor. (*Rochester Naturalist*, 1901.)

Two 18-inch-borings about 200 yards apart.

Yield about 15,000 gallons an hour from each.

		Thickness.	Depth.
		Ft.	Ft.
[Drift]	Chalk [? reconstructed]	5½	5½
	Gravel	3	8½
[Upper Chalk]	Chalk	16½	25
	Chalk and flints ...	30	55

2. Electric Light Works, on the bank of the Medway.

15 feet above Ordnance Datum.

Made and communicated by Mr. R. D. Batchelor. (*Rochester Naturalist*, 1901.)

Shaft 22 feet, the rest a 12-inch boring.

Water-level 12 feet down. Yield 36,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[? Made Earth and Alluvium]	Loam	10	10
	River-clay ...	10	20
	Clay	2	22
[River Drift, 24 feet]	Fine gravel ...	6	28
	Live gravel ...	5	33
	Sharp gravel ...	11¼	44¼
	Gravel and chalk	1¾	46
[Upper and ? Middle Chalk]	Chalk	97	143
	Hard chalk ...	2	145
	Chalk and flints ...	16	161
	Hard chalk ...	15	176
	Chalk	51	227
	Chalk and flints ...	31	258
	Chalk	15½	273½
	Very hard chalk	30½	394
	Chalk	44¾	348¾

Total given as 10 feet less.

3. [? Lion] Brewery. Messrs. C. Arkcoll & Co..

23 feet above Ordnance Datum.
Made and communicated by Mr. R. D. Batchelor. (*Rochester Naturalist*, 1901.)
Shaft 25 feet, the rest bored.
Water-level 10 feet down. Yield tested to 10,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Soil	... ...	11	11
	Chalk	10	21
[Upper and ? Middle Chalk]	Chalk and flints ...	121	142
	Chalk	80	222
	Soft chalk	29	251
	Hard chalk	22	273
	Hard white chalk ...	6½	279½
	Marly chalk	10½	290
	Hard chalk	16½	306½
	Soft chalk	1½	308
	Marly chalk	50	358
	Soft chalk with water	27	385

Total given as 330½.

4. Rochester, Chatham and District Laundry Co.

Made and communicated by Mr. R. D. Batchelor, 1899. (*Rochester Naturalist*, 1901.)
Water-level 14½ feet down.
Shaft 14½ feet, the rest bored, lined 30 feet down with tubes of 9 inches diameter.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Gravel, lively...	25½	25½
[Upper Chalk]	Chalk	6	31½
	Flint and sand	2	33½
	Chalk	3	36½
	Flint and sand	2	38½
	Chalk	3	41½
	Chalk and sand	2	43½
	Flint ,, ,,	1½	45
	Chalk ,, ,,	2½	47½
	Chalk	3	50½
	Flint and sand	1½	52
	Chalk and flint	2	54

The occurrence of sand with some of the flint-layers is remarkable: it is probably owing to downward washing along fissures.

5. Victualling Office Wharf.

Mr. Topley has left a note of a boring of 13 inches diameter here, which was 50 feet to and 290 in Chalk, with a yield of 32,000 gallons an hour, but which had ceased to be used.

In Sir J. Prestwich's MSS. there is a note of a well at Rochester Castle 620 feet deep and of another at the Gas Works 650 feet deep, clay being touched; but no water was got in either.

Rochester Waterworks, *see* **Chatham.**

Romney Marsh Rural District.

Writing of this district, in his Report to the Local Government Board, November 1901, p. 2, Dr. W. W. E. Fletcher says: "There is no public water service. Throughout the district great difficulty is experienced in obtaining supplies of water for domestic use. All the wells seen by me were of the shallow surface type, dry-steined with bricks or stone, and obviously fed by sub-soil water. According to my information, wells of this character alone can be used; for, if they be carried to a greater depth than that to which the loose sub-soil extends, they enter a peaty bed, and the water becomes dark-coloured and unpleasant to the taste; while, if sunk still deeper into gravel underlying clay which is subjacent to the peaty bed . . the water obtained is too brackish for use."

A public well "about thirty yards outside the churchyard" at Newchurch "is said to be a 'tube well' sunk through clay to a depth of 60 feet, and the water is alleged to contain 40 to 50 grains of sodium chloride per gallon. . . At Old Romney a well was observed only four yards distant from a privy cesspit. At Brookland there are at least two wells which are said to yield ample supply of water at all seasons; but, speaking of the district generally, as would be expected when reliance is put upon surface wells, the supplies run short in summer and during prolonged drought."

Ruckinge. Langdon Farm.

Ordn. Map 305, new ser.; Geol. Map 4.
Information from Mr. E. Lord, 1906.

Some years ago a well was sunk to the depth of 223 feet, when fresh water was found after passing through rock, and it is said that a seam of coal [lignite] was found. For details of the beds near here see the account of a trial-boring on p. 235.

St. Paul's Cray.

Ordn. Map 271, new ser.; Geol. Map 6, and London Sheet 4 (new).

1. Chapman's Cottages, near the Bull Inn.

About 133 feet above Ordnance Datum.

2. Gray's Farm.

Level of road 145 feet above Ordnance Datum.
Shafts. Communicated by Mr. W. Morris.

	1		2	
	Ft.		Ft.	
Water-level from surface... ...	30		32	
Steined, to Chalk [? to firm chalk]	14	33	32	36
Chalk	19		4	

Saltwood.

Ordn. Map 305, new ser.; Geol. Maps 3 and 4?

1. Just north of Bluehouse. Trial-boring for Hythe Waterworks. 1895.

Communicated by Mr. C. Jones, Borough Surveyor (words in brackets from specimens).

326·8 feet above Ordnance Datum.

Water-level 21st September, 1905, 99 feet down; 12th October, 99 feet 8 inches. The main source is between 106½ and 118 feet down. Test-pumping was hindered by the great inflow of sand

Tubes to 129 feet down, beginning with diameter of 14 inches, decreased to 12 inches.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Soil	0	6	0	6
	Chalk marl [? wash]	7	4	7	10
	Gault	69	8	77	0
[Folkestone Beds]	Rock (sandstone, calcareous, with much glauconite)	6	6	83	6
	Clay and sand...	23	0	106	6
	Coarse sand	1	0	107	6
	Sand (light-coloured, sharp) ...	10	6	118	0
	Clay and sand...	3	6	121	6
	Rock (sandstone, calcareous only in parts, with much glauconite) ...	1	9	123	3
	Clay and sand (3 specimens from 157½ to 167 feet were sand, the lowest slightly clayey. One at 182 was rather more clayey) ...	65	9	189	0

It was found impossible to get lower.

A paper on "The Water Supply of Hythe" was contributed by Mr. C. Jones to the meeting of the Association of Water Engineers at Birmingham, in June, 1908.

2. For Hythe Waterworks, 1884 (?), a third of a mile N.W. of the Castle.

Communicated by Mr. G. Wilks, Town Clerk of Hythe. (*S.E. Naturalist*, 1902.)

Shaft 108 feet, the rest bored. Water-level, before boring, about 81 feet down; after boring, 6½ feet higher.

In November, 1899, the yield varied from 24,432 to 32,000 gallons in 24 hours.

		Thickness.	Depth.
		Ft.	Ft.
	Brickwork [see below]	66	66
[Hythe Beds]	Rock	30	96
	Sand	6⅔	102⅔
	Rock	? 5⅓	108
	Clayey sand [? any rock] ...	45	153
[Atherfield]	Dark stiff clay, with *Corbula*	4	157

Mr. Topley thought that part of the clayey sand might belong to the Atherfield Clay.

An account of the trial-boring for the Saltwood Well, in a letter from Mr. F. Brady to Mr. Wilks (1874), gives further details of the higher beds, as follows:—

	Thickness.	Depth.
	Ft.	Ft.
Brickearth	13	13
[? Folkestone Beds] White running sand, with water	9	22
Sandgate Beds. Dark green impermeable sand ...	41	63
Hythe Beds. Rag hassock and sand...	14	77

Mr. F. W. TURNER also gave me the following notes on the well in 1898. There is a heading, with base 100 feet down, 6½ feet high, 8 broad and 101 long, running south-eastward. These show marked fissures in the rock at top and at bottom. The sides are bricked, being in sandy material. The floor-rock is 2 feet thick. Foul air comes in quickly, with low barometer and S.W. wind.

3. SANDLING PARK, S.W. of the house.

Made and communicated by Messrs. LE GRAND and SUTCLIFF. (*S.E. Naturalist*, 1902.)

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Dug well (the rest bored)		—	—	36	0
[Sandgate Beds]	Blue clay and sand, in layers...	40	0	76	0
	Hard blue clay and little sand	6	0	82	0
	Blue clay and green sand ...	26	0	108	0
	Hard green sand and little clay	1	6	109	6
[Hythe Beds]	Green sandstone	1	0	110	6
	Green sand and clay	0	10	111	4
	Green rock	0	11	112	3
	Green sand and clay	2	3	114	6
	Green sandstone	2	4	116	10
	Green sand and clay	4	8	121	6
	Green sandstone	3	2	124	8
	Green sand and clay	2	4	127	0
	Green sand	0	6	127	6

Sandwich.

Ordn. Map 290, new ser.; Geol Map 3.

1. THE BANK. 1790.

Communicated by Mr. E. F. S. READER.
Water rose to within 20 feet of the surface.

			Thickness.	Depth.
			Ft.	Ft.
Made earth	... ...	about	7	7
[Alluvial]	Red iron-stained clay ...	„	3	10
	Loose boulders	„	2½	12½
	Sand	„	2½	15
	Sand ... ... Timber, turned blue [? with phosphate of iron]... ... Clay	„	20	35
[? what]	Shells	„	5	40
[Thanet Beds]	Clay or marl	„	20	60
	Pipe-clay to flint and chalk...	„	2	62

2. GILLOW'S BREWERY.

Communicated by Messrs. S. F. BAKER & SONS.
To Chalk, 46 feet.

WATERWORKS, *see* **Woodnesborough.**

Seal. Fawkes Wood. For Mr. V. Blagden. 1902.

Ordn. Map 287, new ser.; Geol. Map 6.
Made and communicated by Messrs. Le Grand and Sutcliff.
No yield. Shot fired about 179 feet down, where there was a little water, but no good resulted.

		Thickness.	Depth.
		Ft.	Ft.
Soil	... ...	2	2
[Hythe Beds, 183 feet]	Sandy marl and rock	6	8
	Kentish rag... ...	8	16
	Loamy sand... ...	19	35
	Rag	6	41
	Sand and rock ...	49	90
	Rock...	25	115
	Sand and rock ...	6	121
	Rock...	6½	127½
	Sand and rock ...	10½	138
	Rock...	39	177
	Blue sandstone ...	8	185
[Atherfield Clay]	Sandy blue clay ...	21	206
	Blue clay	1	207

The great thickness of the Hythe Beds here is notable, being a little more than double that found in the boring at Kemsing, by the edge of the Gault, northward. Moreover here the topmost part of the division is absent.

Sevenoaks.

Ordn. Map 287, new ser.; Geol. Map 6.

1. Bat and Ball Station, London, Chatham and Dover Railway. 1886.

Made and communicated by Messrs. S. F. Baker & Son.
Shaft 29 feet, the rest bored.

Water overflows. According to the Engineer, February, 1896, it rises up, from the boring, to the bottom of the tank, which is some 20 feet above the ground. About 60,000 gallons a day are used.

		Thickness.	Depth.
		Ft.	Ft.
Mould	... ...	1⅓	1⅓
[Folkestone Beds]	Loam, with layers of sandstone ...	1⅔	3
	Sand, with layers of stone	5¾	8¾
	Running sand, with water	9¼	18
	Loamy sand	10½	28½
	Sand, with 4 inches of stone at the bottom	11½	40
	Sand	10½	50½
	Hard sand and pebbles	4	54½
	Hard sand	6	60½
	Soft stone	3	63½
	Very hard sandstone-rock [? to sand]	4	67½

2. GASWORKS.

Communicated by Mr. F. HUNTER. Bored by Messrs. ISLER.
Shaft 12 feet, the rest bored.
20 feet of tubes, of 7¼ inches diameter, 11 feet down; 115 feet, of 6 inches diameter, at surface.
Water overflows (? 14 feet above the ground).
Supply 12,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Folkestone Beds]	Yellow sand	14	14
	Sand	35	49
	Running sand	23	72
	Rock	2	74
	Sharp sand	16	90
	Red sand	5	95
	Sharp sand	17	112
	Sand	12	124
[Sandgate] Beds]	Green sand	6	130
	Mottled clay	3	133
[Hythe Beds]	Sandstone, with water	7	140

Four specimens (without depths marked) were of iron-sandstone, of sandy clay and of red clay (presumably both from Sandgate Beds) and of chert (presumably from Hythe Beds).

3. Mr. J. GOLDING'S BREWERY, near Railway Station. 1900.

Made and communicated (1901) by Messrs. ISLER & Co.
25 feet of tubes, of 7¼ inches diameter, to 4 feet above the surface; 90 feet, of 6 inches diameter, 10 feet down [or ? 10 feet above surface].
Water overflows, 10 feet above the surface, at the rate of 1,500 gallons an hour. Pumping at 7,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Folkestone Beds]	Light-coloured sand ...	20	20
	Sandstone (or red sand)	10	30
	Live sand	17½	47½
	Ironstone rock ...	¾	48¼
	Dead grey sand ...	26¼	75
[? Sandgate Beds]	Dead green sand ...	5	80
	Brown marl	4	84
	Rock	3½	87½

4. SHANGDON. For Knowle House, &c.

From information on the spot.
Ground-level 435 feet and water-level 315 above Ordnance Datum, according to Dr. TEW.
Well 195 feet, with a heading of 60 feet.

5. WATERWORKS. In the bottom of the valley on the northern side of Oak Lane, W.S.W. of the Church. 1864.

Shaft and galleries in the Kentish Rag. Water partly got by means of the railway-tunnel.

The following remarks are by Mr. J. LUCAS, *Trans. Inst. Surveyors*, vol. xiii., p. 173 (1881):—" The existence of certain synclinals in the strata has gathered the subterranean waters into certain lines. The Sevenoaks Tunnel, which falls all the way towards Tunbridge, cut through one of these close to the northern end, and the stream flows out at the southern end, where it was delivering . . 20,640 gallons per day —May 29th, 1880." "At the northern end, the Sevenoaks Water Company have sunk a well right on to it, and give . . therefrom a constant supply of 150,000 gallons per day; this added to the above flow=170,640 gallons."

The following districts are also in the area supplied:—Riverhead, Seal The Weald. (Water Works Directory, 1907.)

See also **Kemsing**.

Sheerness.

Ordn. Map 272, new ser.; Geol. Map 2.

1. DOCKYARD. 1864. Deepened 1896.

Communicated by Lt.-Col. C. PASLEY, R.E., to the depth of 455 feet.
Later information from Lt.-Col. RABAN, R.E.
About 13 feet above mean water-level.
Shaft and cylinders about 330 feet, the rest bored.
Water rose to about 53 feet down, and the yield was 675 gallons an hour.

There are two wells, the old well about 240 yards westward of the chapel (? 363 feet deep), the new well by the boundary of the yard, about 360 yards north-westward from the chapel (? 455 feet deep). The account of the upper part of the following section (published in "The Geology of the London Basin," 1872) refers to the old well, whilst that of the lower part (below 455 feet) is from a section purporting to belong to the new well. As, however, it agrees with the former in its upper part (except for a few matters of inches) the two accounts are now combined, the figures of the later being taken, and any notable difference being noted. Notes of some specimens that I have seen, from 460 to 500 feet, are also given.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Soil]	Common earth (3 feet in older account) ...	4	6	4	6
[Alluvium, 77 feet]	Stiff brown clay	11	5	15	11
	Clay and dark silt	0	11	16	10
	Running silt	31	2	48	0
	Hard silt	33	6	81	6
[River Drift]	Gravel	5	6	87	0
[London Clay, 262¾ feet]	London Clay (264 in old account) ...	262	6	349	6
	[Basement-bed] Green sand. Water first found	0	3	349	9
[Oldhaven Beds]	Light-coloured sandy rock ...	14	3	364	0
[Woolwich Beds, nearly 53 feet]	Dark sand and clay	7	0	371	0
	Dark sand, clay and shells	5	0	376	0
	Dark stiff clay, with a 3-inch layer of pyrites 8 feet down	14	0	390	0
	Light-green sand, dirty	1	0	391	0
	Dark stiff clay with a thin layer of green sand in the upper part ...	11	6	402	6
	Dirty green sand	2	6	405	0
	Dark stiff clay, the lower 2 feet less hard than the rest	3	0	408	0
	Sharp light-coloured sand	7	10	415	10
	Hard [flint] pebbles and pyrites ...	1	0	416	10

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Thanet Beds, over 93 feet]	Green sandy loam (2 feet less in older account)	19	2	436	0
	Sandy loam and rotten shells (16 feet in older account)	14	0	450	0
	Green sandy loam	5	0	455	0
	Sandy loam (specimen from 460 feet grey)	5	0	460	0
	Clay (specimen from 470 feet greenish grey and sandy)	10	0	470	0
	Very hard clay (specimen from 480 feet grey and sandy)	11	0	481	0
	Clay, with flints (specimens, from 490 feet grey sandy clay, from 500 feet grey and greenish sandy clay. There are also green-coated flints)	29	0	510	0
[Upper and ? Middle] Chalk, with flints (a sample from 975 feet Mr. JUKES-BROWNE reports as greyish and gritty, and another from 980 feet as very gritty, with some green grains and like mashed-up Chalk Rock)		470	9	980	9

It has been recorded, by the Admiralty Department of Works, that when the Shoeburyness boring, on the opposite coast of Essex, was being made, the level of the water in this well (or other Government one) was lowered 17 feet. The distance is about 6 miles. The Essex boring (at South Shoebury) is described in the *Essex Naturalist*, vol. vii., pp. 56--58. It reaches the Chalk at the depth of 587 feet, and continues in the Chalk to 1,048 feet. See also p. 197.

2, 3. Fort Townshend.

Old Well. 1782.

Phil. Trans., vol. lxxiv., p. 6, and plate (1784).

Water rose to within 8 feet of the surface.

The figures in the second column are from a drawing in the library of the Geological Society, according to which there was "a piece of a large tree" 300 feet down, and "quicksand with strong springs" was touched at the bottom.

			Ft.	Ft.
Blue marl [alluvial clay]		... ... about	8	8
[Valley Drift]	Quicksand (salt water at bottom)	... ... „	12	10
	Gravel ...	... ... „	6	8
	Quicksand (salt water at bottom)	... ... „	14	10
	Gravel ...	... ... „	12	6
[London Clay] ...		... ... „	? 278	—
		Bottom blew up at	330	330

Later information, given by Lt.-Col. E. C. SIM, in 1880, shows that the well was carried deeper:—

Shaft 336 feet, and bore-pipe, of 9 inches diameter, to 112 feet further.

Water-level about 75 feet down.

The bottom of the well has been loaded with shingle, to a depth of 80 feet, to prevent the sand from choking the bore-pipe.

On February 8th, 1878, at about 1.30 p.m., a loud noise was heard coming from the bottom of the well. It continued until 2.45 p.m., and immediately afterwards the water rose from 162 feet to 107 feet from the surface.

A well described in *European Mag.*, vol. ii., p. 430 (1872), as 200 yards W. of the Fort, is presumably another version of the above. The water is said to have risen to within 40 feet of the surface and the section is given as follows:—

Mud		27	302 feet
Gravel	about	5	
Dark brown marl	„	260	
Sand (to water) with pieces of chalk	„	10	

New well, about 23 feet from the old well.

Communicated by Lt.-Col. E. C. Sim, R.E. (*Rochester Naturalist*, 1901.) Shaft sunk in 1869, to a depth of 204 feet. Boring began January, 1877.

Slight spring of water at 736 feet. At 806 feet water rose to 69½ feet from the surface. Water rises to about 80 feet. Yield about 4,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
From surface, through London Clay, [capped by Alluvium, &c.] ...		336	336
Black clay and sand [? base of London Clay] ...		2	338
[Oldhaven Beds, 20 ft. ?]	Green sand and clay...	12	350
	Grey sand	8	358
[Woolwich and Reading Beds, 42 feet ?]	Black sand	1	359
	Light-coloured clay	3	362
	Green sand	4	366
	Sand-rock	5	371
	Green sand	14	385
	Grey sand	5	390
	Green loamy sand	2	392
	Dark grey sand	3	395
	Green sand	5	400
[Thanet Beds, 101 feet ?]	Dark (black) sand	22	422
	Dark sand and rotten shell intermixed	32	454
	Soft sand-rock	23	477
	Dark blue sandy clay	24	501
Chalk and flints		305	806

It is difficult to mark the divisions of the Tertiary Beds, even with the aid of the new Town well.

4, 5. Waterworks. Between Miletown and Bluetown.

Old Well. 1863.

Communicated by the Surveyor to the Board.

Surface 5½ feet above Ordnance Datum.

? Shaft 300 feet; bore 80 feet (14 inches diameter). Yield about 10,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 47 feet]	Clay	9	9
	Shingle...	3	12
	Black mud	35	47

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 293 feet]	Yellow clay	3	50
	Clay	160	210
	Hard clay mixed with flint [?] ...	5	215
	Hard brown clay	4	219
	Brown marl, close and hard, with pyrites, shell, and cement-stone	91	310
	Hard laminated clay...	28	338
	Hard clay mixed with stone [basement-bed ?]	2	340
[Oldhaven Beds, 19 feet]	Loam and sand full of water ...	10	350
	Thin layer of pebbles	½	350½
	Black clay with pebbles	1	351½
	Dark green sand with pebbles ...	7½	359
[Woolwich Beds, 25 feet]	Black loam	1	360
	Marl and peat [lignite]	2	362
	Marl, close and hard...	1	363
	White sand	3	366
	Brown sand	4	370
	Yellow loam	½	370½
	Quick green sand	10½	381
	Hard green sand	3	384

The Thanet Sand may have been reached and the well may have been deepened.

Mr. B. **Latham** described a well here, in 1864 (*Trans. Soc. Eng.*, p. 244), and by a slip credited the water-supply to Upper Greensand. He says that "at the restoring of the well it yielded water at the rate of 220,000 gallons every twenty-four hours."

The following information as to yield, etc., at the Waterworks probably refers to the new well, an account of which follows.

Mr. V. A. **Stallon** wrote, in July 1894, that the yield would not be more than at the rate of 19,000 gallons an hour, continuously for twenty-four hours.

Mr. W. H. **Booth** wrote, in May 1902, that 22,000 gallons an hour were being pumped for ten or twelve hours a day. The water-level started at 170 feet down and finished at 270.

New Town Well. 1878.

W. H. **Shrubsole**, *Proc. Geol. Assoc.*, vol. v., no. 7, pp. 355-362.

Shaft 335 feet, the rest bored. Connected with the older well by a gallery at 200 feet.

A letter from Mr. **Shrubsole** (1907) says that there has been a great accumulation of sand in the borehole.

		Thickness	Depth.
		Ft.	Ft.
Made ground		3	3
[Alluvium, 44 feet]	Soft blue mud...	9⅔	12⅔
	Soft black mud, with a vein of sand on top	3	15⅔
	Soft blue mud. A layer of peat 30 feet down, with roots of grasses and aquatic plants just below ...	28⅓	44
	Black peaty mud and water ...	2	46
	Light-brown or yellow loam or clay with flints	1	47

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 291 feet]	Light-brown clay, then streaked with blue, then pale blue... ...	23	70
	Blue clay with septaria. At 220 feet more shaly. At 230 feet of a grey slate-colour. At 240 feet marly. Then harder and darker	203	273
	Dark blue clay, with pyrites and wood. At 335 feet a greenish tint with a little sand	65	338
[Oldhaven Beds, 21 feet.]	Green sandy rock, with very little water	8	346
	Grey sandy rock, with fossils and little water	8	354
	Dark sandy crusty rock, with pebbles	5	359
[Woolwich and Reading Beds, 26 feet.]	Dark clay, with lignite on top ...	3	362
	Reddish sand with a little water ...	2	364
	Hard red sand-rock, with veins of pyrites and a little water ...	5	369
	Very light-coloured sand-rock, with a little water...	1	370
	Dry sandy loam	2	372
	Greenish sand, pebbles and pyrites	11	383
	Very hard tough dark green clay ...	2	385
[Thanet Beds, 117 feet ?]	Grey sand, with pyrites and beds of sand-rock. Good spring of water rose to 160 feet from the surface whilst pumping was going on ...	10	395
	Green sandy loam	5	400
	Green sandy loam with shelly rock, pebbles and some water	12	412
	Grey loamy sand, rotten shells and fish-teeth	13	425
	Loamy sand and rotten shells ...	15	440
	Loamy sand and pyrites, and vein of sand with water...	3	443
	Loamy sand and rotten shells ...	5	448
	Sandy clay and sandstones ...	22	470
	Dark green sandy clay	1½	471½
	Brown sandy clay	28½	500
	Flints in clay	2	502
[Chalk, 303 feet]	Flints and chalk	1	503
	Chalk-rubble, with dirty vein or pot-hole	50	553
	White chalk with flints. A little water at 670 feet	117	670
	White chalk with flints. No water	58	728
	Yellow gritty chalk with flints. At 738 feet water rose to 100 feet from the surface	10	738
	Chalk with flints; and fissures with good supply of water	12	750
	White chalk with flints	20	770
	Small fissure in chalk, with flints and a little water	3	773
	Hard dull sticky chalk. No water	32	805

Many fossils, especially Foraminifera, were found in the London Clay.

It is hard to fix the division between the Woolwich and the Thanet Beds, and it may be that the higher beds marked as belonging to the latter really belong to the former.

The daily supply of these works is 230,000 gallons. (Water Works Directory, 1907.)

M. HERICART DE THURY (Considérations . . . sur la Cause du Jaillisement des Eaux des Puits Forés, 8º *Paris*, 1829), notes a well at Sheerness as 300 feet through clay to gravel, the water overflowing.

Sir J. PRESTWICH says that two wells here give a thickness of 347 and of 356 feet to the London Clay (*Quart. Journ. Geol. Soc.*, vol. x., p. 404). Thickness here probably means depth to the base.

The following is from an article, "The Water Supply of Sheerness," in the *Building News* of July 8th, 1864, pp. 514, 515:—

"About the year 1800 the Board of Ordnance decided to sink a well in a marsh within the fortifications, and since known as 'Well Marsh.' This well is . . carried to the depth of 333 ft. [Presumably, therefore, it is the one at Fort Townsend.] When the water began to accumulate in this well, the . . supply of water in the wells at Southend [about eight miles across the estuary of the Thames] was materially diminished." It is interesting to have this story of communication between Kent and Essex from two of the Sheerness wells. See also p. 193.

Sheppey, *see* Eastchurch, Harty, Minster, Queenborough, Sheerness.

Shoreham. THE PLACE. 1877 ?

PRESTWICH. *Quart. Journ. Geol. Soc.*, vol. xxxiv., pp. 909, 911.
Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, London District, Sheet 4 (new).
194 feet above the sea.
Shaft 25 feet, the rest bored.

Water (slightly ferruginous) rose to a height of over 12 feet above the surface of the ground; but the small borehole got largely filled with sand.

		Thickness.	Depth.
		Ft.	Ft.
Soil and chalk-rubble		13	13
Chalk, 200 feet	Chalk without flints, very hard ...	112	125
	Chalk Marl, very clayey (stiff brown clay with thin veins of chalk, according to Messrs. BAKER) ...	88	213
Upper Greensand		10	223
Gault		226	449
Lower Greensand.	Sand and sandstone	26	475

Shorncliff, *see* Cheriton.

Shorne.

Ordn. Map 272, new ser.; Geol. Map 1, S.E.

1. BRITISH URALITE CO. By the edge of the Marsh, westward of Higham. Bored well.

		Thickness.	Depth.
		Ft.	Ft.
Soil		3	3
[River Drift]	Sandy gravel	3	6
	Coarse gravel	10½	16½
[London Clay, 38½ feet]	Hard blue clay, with shells from 31 to 37 feet down	28½	45
	Grey sandy clay	10	55
[Oldhaven, Woolwich and Thanet Beds]	Dead grey sand	6	61
	Sand and pebbles	5	66
	Hard sand	2	68
	Sand and pebbles	6	74
	Grey sand	81	155
Chalk and flints		195	350

Another version of a boring here, perhaps a different one, made and communicated by Messrs. LE GRAND and SUTCLIFF, is as follows; the site being 100 yards W. of the Canal, where the railway to Port Victoria crosses it:—

Ballast, peat, etc.	24	142 feet to Chalk
Sandy clays, pebbles, sand, etc.	22	
Thanet Sand [must include Woolwich and perhaps Oldhaven Beds]	96	

2. SHORNE MEADE FORT. 1863.

Sunk and communicated by Messrs. DOCWRA.
Surface a few feet below high-water in the Thames.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Alluvium 34 feet]	Mud	12	3	12	3
	Peat	1	0	13	3
	Mud	11	9	25	0
	Peat	3	0	28	0
	Mud	5	0	33	0
	Peat	1	0	34	0
	Sand and pebbles	6	6	40	6
	Clay and pebbles	5	6	46	0
	Sand and pebbles	2	0	48	0
	Clay	3	6	51	6
	Gravel	12	0	63	6
	Hard loamy sand and clay	13	10	77	4
Soft chalk	... ...	34	8	112	0

Shortlands, *see* **Beckenham.**

Sidcup, *see* **Bexley.**

Sissinghurst, *see* **Cranbrook.**

Sittingbourne. LLOYD'S DAILY CHRONICLE MILLS. 1886.

Ordn. Map 272, new ser.; Geol. Map 3.
Made and communicated by Mr. R. D. BATCHELOR.
(*Rochester Naturalist*, 1901.)
Bored throughout (18 inches diameter).

Cut water (small soakage) at 54 feet. Little water at 188. Cut water at 255. Found most water at 319 and 373. This water overflows into the mill-stream, at the rate of about 60 tons an hour (= 334,560 gallons in 24 hours).

		Thickness.	Depth.
		Ft.	Ft.
Made ground	... ...	3	3
[River Drift]	Mild brickearth	6	9
	Small [fine] gravel	4	13
[Upper Chalk, 242 feet]	Soft glutinous chalk and flints ...	23	36
	Chalk and flints	102	138
	Hard white rock	8½	146½
	Chalk and flints	23½	170
	Chalk and flints, with layers of rock	12	182
	Rocky chalk	5	187
	Chalk rock	¾	187¾
	Hard rocky chalk	67¼	255

		Thickness.	Depth.
		Ft.	Ft.
[Middle Chalk, 226 feet]	Soft white chalk without flints ...	15	270
	Hard dark chalk	15	285
	Hard chalk, few flints	11	296
	White chalk, without flints	26	322
	White chalk, with beds of rock 2 feet thick and about 5 feet apart	20	342
	Hard chalk	12	354
	Chalk with layers of rock	19	373
	Very hard rocky chalk	48	421
	Hard white rock	55½	476½
	Dark chalk	5	481½
[Lower Chalk, 38½ feet]	White chalk	14	495½
	Darker chalk	17	512½
	Dark marly chalk, believed to be near the top of the grey chalk ...	7½	520

The divisions of the Chalk suggested by Mr. A. J. Jukes-Browne.

Waterworks, *see* **Bobbing.**

Snodland.

Ordn. Map 272, new ser.; Geol. Map 6.

1. Mr. S. Crowhurst's.

Made and communicated by Messrs. Le Grand and Sutcliff.
(*Rochester Naturalist*, 1901.)
Water-level 29 feet down, in April, 1890.

		Thickness.	Depth.
		Ft.	Ft.
[River Drift]	Loam	10	10
	Loam and red sand with white stones	5	15
	Loamy sand	11	26
	Gravel	1½	27½
[Gault]	Grey and loamy clay	1	28½
	Gault	69½	98
	Blue clay	17	115
	Clay and greensand	3	118
	Black pebbles [Phosphatic nodules?]	2	120
[Folkestone Beds]	Green sand	27½	147½

2. At Messrs. Hook & Co.'s Paper Mill, by the creek S. of the Church, there is a well to Lower Greensand, from which about 25,000 gallons an hour have been pumped continuously.

3. Locality not given. (Weald Memoir, p. 140).

Mr. Topley says that "in a well . . which commenced in the Gault and passed through the whole thickness of the sands (Folkestone Beds), they were 100 feet."

South Kent Water Co., *see* Brambridge.

Southborough. Waterworks. In the Valley at the southern side of the Common. 1896.

Made and communicated by Messrs. Isler & Co.

Lined with 50 feet of tubes, of 13½ inches diameter, from 6 feet down; with 180 feet, of 11½ inches diameter, from 8 feet down; and with 221 feet of 10 inches diameter, from 180 feet down.

Water-level 102 feet down (when the boring was 401 feet down). Supply reduced, after pumping continuously (day and night) for 10 days, to 1,500 gallons an hour.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Well (the rest bored)		—		9	0
	Hard shale	19	0	28	0
[Wadhurst Clay]	Hard blue clay	8	0	36	0
	Hard blue stone	151	0	187	0
	Hard grey stone	8	0	195	0
	Rock	2	6	197	6
	Brown clay	5	6	203	0
	Blue stone	2	6	205	6
	Hard brown clay	22	0	227	6
	Brown loamy clay	30	0	257	6
[Ashdown Beds, 143½ feet]	Hard grey stone	14	3	271	9
	Hard grey clay and stone	22	9	294	6
	Hard white sandstone [a specimen of lignite from about 305 feet] ...	10	6	305	0
	Hard brown clay	4	0	309	0
	Very hard stone	9	0	318	0
	Hard brown clay [a specimen of fine very pale brownish-grey sand, with bits of lignite, from about 325 feet]	8	4	326	4
	Hard grey clay and stone	9	0	335	4
	Hard sand-rock	8	6	343	10
	Hard clay	6	6	350	4
	Very hard rock	2	6	352	10
	Blue clay and stone	12	0	364	10
	Very hard stone	3	0	367	10
	Very hard grey clay	17	4	385	2
	Very hard stone	15	11	401	1
[? Fairlight Beds]	Mottled clays...	? 31	11	433	0
	Very hard stone	0	6	433	6

Messrs. HODSON write of a boring at Upper Haydon Farm (or Upper Hayenden ?) in connection with the supply of Southborough, as follows:— "The first 50 feet of boring appears to prove that an ancient river-valley has been silted up with the detritus of Wadhurst (Clay) and other rubbish. At 52 feet we pierced a bed of river-gravel and got some flints and some worn down Tunbridge Wells rock. After this we got the regular Ashdown sands and clays [to 270 feet]. . . We got no water until we reached the gravel at 52 feet, when it rose to 14 feet from the surface, and it commenced to overflow at 223 feet, but the overflow is very weak."

Dr. F. PARSONS describes the well as 103 feet, and the trial-boring as 330. He says that the yield is 120,000 gallons in 24 hours, the greater part of the water coming from the layer of gravel about 50 feet down.

He also notes a trial-boring at Modest Corner (abandoned) as going through 180 feet of Wadhurst Clay into Ashdown Sand, in which water was met with at 190 feet and rose to 120.

Southfleet. METROPOLITAN WATER BOARD'S PUMPING STATION. Five-sixths of a mile W. of N. from Church.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., and London and its Environs.
From the Engineer's Report (W. MORRIS), prepared for the Metropolitan Water Board Arbitrators, 1903.
70 feet above Ordnance Datum.

Shaft and cylinders about 100 feet, with a heading close to the bottom, to the boring, which is at a slightly lower level. A second well was to be sunk.

Original water-level about 48 feet down. On September 12th, 1903, with continuous pumping, about 86.

Brickearth	about	13½	200 feet
Sand ...	„	2½	
Chalk ...	„	184	

Stanford. WESTENHANGER. Boring.

Ordn. Map 305, new ser.; Geol. Map 3.

From Mr. H. B. MACKESON (amongst Mr. Topley's notes). No water.

Sandgate Beds	? 20 feet
Hythe Beds ...	59 feet
Atherfield Clay	
Weald Clay	

Stone.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).

1. E.C. POWDER Co., at Bean, on the Tertiary outlier S. of the village.

Made and communicated by Messrs. ISLER & Co.

Brick shaft 138 feet, then cylinders of 5 feet internal diameter for 70 feet, the rest a boring of 10 inches diameter.

Water met with 215 feet down and rose 6 feet. Yield 5,000 gallons an hour, minimum 3,500.

	Thickness.	Depth.
	Ft.	Ft.
Light-yellow fine sand and conglomerate [Woolwich Beds and Thanet Sand]	138	138
Dead green [Thanet] sand, with layers of ironstone	12	150
Chalk and flints, hard in the boring...	150	300

2. HORNS CROSS.

Dr. J. MITCHELL'S MSS., vol. i., p. 46, in Libr. Geol. Soc.

Gravel and flints	45	115 feet
Chalk	70	

Stourmouth. (WEST STOURMOUTH of New Map).

STOURMOUTH HOUSE.

Ordn. Map 273, new ser.; Geol. Map 3.

G. DOWKER, *Geologist*, vol. iv., p. 213 (1861).

		Thickness.	Depth.
		Ft.	Ft.
[? Brickearth] Clay with sand, the lower part ferruginous and very sandy		14	14
[? Woolwich Beds, 25 feet]	Iron-sandstone	1	15
	Greenish quicksand	23	38
	Small [flint] pebbles	1	39
[Thanet Beds, 99 feet]	Shell-marl	6	45
	Blue clay [sandy marl]	93	138
Chalk, with a bed of tabular flint, a foot thick at top [? including the green-coated flints that occur at the base of the Thanet Beds]		21	159

Strood.

Ordn. Map 272, new ser.; Geol. Map 6.

1. Messrs. Burge & Co.'s Cement Works, by the river-side a short way from the Railway Station. 1887.

Made and communicated by Messrs. Le Grand and Sutcliff.

Water salt from below, whilst scarcely brackish near the surface.
Chalk and flints, 201½ feet.

2. Stewart Bros. & Spencer's Oil Mills. 1886.

? About 15 feet above Ordnance Datum.

From an account in the *Chatham and Rochester Observer*, March 6th, 1886, and from information from Messrs. Tilley, who made the boring. (*Quart. Journ. Geol. Soc.*, vol. xliii., p. 204.)

Water overflows in large quantity (? 150 gallons a minute), and it overflowed through a small pipe to a height of 45 feet above the ground. Temperature 62½° Fahr.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Mud [Alluvium]		42	0	42	0
[Chalk, 505 feet]	Upper Chalk, with flints	305	0	347	0
	Lower Chalk and Chalk Marl ...	194	0	541	0
	Upper Greensand (base of Chalk Marl)	6	0	547	0
Gault (2 inches of rock at the base on one side, 4 inches on the other)...		195	2	742	2
Lower Greensand: fine sharp greenish-grey sand, with water		14	10	757	0

3. Waterworks, on the southern side of the high road, about a third of a mile W. of St. Nicholas Church. 1849 and later.

Communicated by Mr. W. Banks. City Surveyor, Rochester (? 1892).
About 106 feet above Ordnance Datum.

Water-level about 2 feet above Ordnance Datum. Pump about 280,000 gallons a day, lowering the level 5 feet.

Well in Chalk, 132 feet, with heading, about 200 feet long, the bottom 114 feet down.

Yearly supply 97 million gallons. Highest day's supply 302,000, in July. (Water Works Directory, 1907.)

At an extension made in 1886, a "natural heading" was found. There had been a fall before, and along the fissure there was a width of sand of 2 to 3 feet, to a height of 7 or 8.

Whilst the above was being printed a detailed account of the natural gallery was published in a paper by Mr. S. Sills (*Rochester Naturalist*, 1907, vol. iii., no. 97, pp. 466—471 and four plates) and from this the following remarks are taken. The occurrence is so peculiar that no apology is needed for their length, especially as the paper is locally published and therefore not generally accessible.

"A cavern or natural chamber, with a water-course opening out of it, was discovered in 1879. . ."

"This chamber was found to be roughly **Z** shaped on Plan, the stem of the letter lying in the line of fault, which cut the workings from north to south. The upper arm which ran . . west by north was 28 feet long and 10 feet wide, with a height from floor to roof of 12 feet at its western end to 17½ feet where it joined the stem."

"The stem, measuring 16 feet in length between the arms, lay south by south west, the sides slightly converging toward the lower end, the width at junction with upper arm being 12½ feet and at the lower arm 9 feet."

"The lower arm was somewhat lozenge shaped cutting south east 18 feet long and 10 feet wide, as measured in the centre of its length. At the lower end it narrowed down to 3 feet in width and finished in a large fissure which extended from floor to roof."

"At the western end of the upper arm a stream of water enters the cavern by the way of what appeared to be a tunnel-shaped fissure, partially filled with sand and clay."

"The cavern, when opened, was piled with blocks of chalk and débris, and the walls and roof were cracked and splintered to such an extent that ultimately brickwork under-pinning was found to be necessary to prevent further extensive falls of chalk."

"Later work proved the fissure at the western end of the cavern to be much more extensive than it was at first supposed, but it was not until the year 1903 that the extent of this water-course was realized."

"The work in hand at this period included the deepenings of an adjoining adit which drained this channel. As the work proceeded the water flowing from the fissure obtained a more easy egress and washed out quantities of fine sand and clay disolosing a passage of far greater dimensions than was suspected."

"The sand being so fine was swept down and held in suspension by the water in such quantities that a difficulty was experienced in keeping the pumps clear, and it became expedient to remove as much as possible by digging."

"Many tons of clay and sand were removed in this way and day by day the passage deepened and extended until it took the form of a roughly fashioned adit from four to five feet wide and from five to six feet high."

"The passage or adit was explored for a distance of 130 feet from the cavern and at the point where the work was stopped appeared to continue in much the same form."

"When the adit had been so far cleared of detritus the floor was found to be paved with a layer of tabular flint which crossed the passage. The sides of the adit were scored and in many places deeply undercut by the action of the stream. The stream would appear to have found its way primarily along the flint floor and, being intercepted by the fault which crosses the cavern, was diverted toward the big fissure at the end, where it found an exit to the river." (Medway).

"The level of the flint layer . . is about one foot above the low water mark of ordinary tides in the river, and the rise of the tidal waters to 17 or 18 feet above this level would pen up the stream until the ebb released the waters, which would scour down the channel with added force."

"The fine sand and clay washed down from the strata overlying the chalk through pipes or fissures would gradually silt up the stream bed. This silting would be assisted by the periods of comparative quiescence when the stream was held up by the tides, and precipitation of sand held in suspension would be rapid."

"The force of the stream being insufficient to remove this silt, a fresh passage was carved out above it in the chalk already softened by the water's action. . . ."

"The roof of the passage is roughly arched throughout. . . ."

"During the operation of removing the silt, which was mixed with quantities of drift flints, and chalk blocks fallen from the sides of the passage, numerous small streams were discovered issuing from fissures along the sides, but as the work proceeded beyond these fissures the streams ceased to flow and the supply gradually increased from ahead."

"The general direction of the passage was west by north west. . . At various points . . occur pockets or enlargements . . at distances varying from 20 feet to 40."

"If the course of the stream is traced in a series of straight lines, from . . its source, it will be seen that at each change of direction there is one of these chambers."

"Not only is the enlargement horizontal but vertical, and the roof is drilled deeply as if by a large tool in many places. The greater the angle of deviation the more considerable is the enlargement. . . ."

"There are five of these enlargements . . and in the fifth which is right at the end . . at which the work of 1903 finished, a mass of chalk has fallen from the roof which forms a bar right across the passage. Over this barrier the water steadily wells from the unexplored regions beyond. . ."

The roof slopes from the cavern toward the end of the passage "and this gives one the impression that the passage must be rapidly approaching its termination," but he thinks that this is not the case.

The passage "is normally full to the roof with water, and consequently the whole area of sides and roof is always under its solvent influence. The chalk through which the natural passage is driven is particularly soft and susceptible to this action. . . ."

"The roof was studded in places with delicate fossil remains protruding from the eroded surfaces."

In making a short adit, to connect two pump-wells, a mass of hard chalk, with large flints and nodules of iron-pyrites all concreted together, was met with, "along the fault and appeared to be wedge-shaped and of immense proportions."

One of the plates gives sections of the adits and another a plan of the wells and adit, both being by Mr. W. Banks and dated 1903. The other two are views of the natural adit, from photographs.

4, 5. Wickham Cement Works (Martin Earle & Co.).

Two wells. Made and communicated by Mr. R. D. Batchelor.

No. 1, 1898.

Water-level at rest 16¼ feet down ? pumped down to 46 feet.

Shaft, of 8 feet diameter, 40 feet, the rest bored, 4 feet diameter.

		Thickness.		Depth.	
		Ft.	in	Ft.	in.
Chalk	Chalk	23	0	23	0
	Chalk, slippery	10	0	33	0
	Chalk	7	0	40	0
	Chalk and flints	40	11	80	11
	Chalk	2	0	82	11

No. 2, 1900.

Shaft, of 8 feet diameter, 25 feet, the rest bored, 4 feet diameter,

Rest water-level, 14 feet 8 inches down.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
	Made soil	1	7	1	7
[River Drift]	Bull-head ...	1	10	3	5
[Upper Chalk]	Chalk	11	4	14	9
	Chalk and flint	56	3	71	0

Sturry.

Ordn. Maps 273, 289 new ser.; Geol. Map 3.

1. Mrs. THORNTON'S, near the bridge. 1872.

Lt.-Col. Cox, *Kentish Gazette*, May 21st, 1872, and G. DOWKER in discussion.

Water overflows. Bore.

		Thickness.	Depth.
		Ft.	Ft.
Garden and alluvial soil		7	7
Hard Valley gravel		8	15
[Thanet Beds]	Blue clay	4	19
	Gap in description [presumably more clay]	5	24
	Very hard blue clay, dry and greasy	4	28
	Blue clay	12	40
	Rather sandy greenish [clay] ...	4	44
	More sandy	2	46
	More sandy, struck a spring ...	4	50
	Green sand, with water	3	53

2. TILE LODGE FARM. 1890.

Made and communicated by Messrs. ISLER & Co.

(Words and figures in these brackets from another source).

Well 11 feet, the rest bored and lined with 240 feet of tubes, of 3 inches diameter, from a foot below the surface.

Water-level 70 feet down. Supply 140 gallons an hour.

			Thickness.	Depth.
			Ft.	Ft.
[London Clay]	Yellow clay (15)		6	6
	Blue clay (52)		54	60
[Oldhaven, Woolwich and Thanet Beds]	Live and blowing sand (grey quicksand 75)...		77	137
[Thanet Beds]	Dead sand (25)		34	171
	Sand and clay	(Hard blue clay 46)	14	185
	Blue clay		25	210
	Dead sand	(Black sand 14)	6	216
	Undescribed		11	227
(Chalk 74)			—	301

Sundridge.

Ordn. Map 287, new ser.; Geol. Map 6.

1. OVENDEN HOUSE. [? Ovingden Green of old map, Combebank Farm of new map.]

About 370 feet above Ordnance Datum ?

Made and communicated by Messrs. TILLEY.

Water-level 78 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		2½	2½
[Gault, 243½ feet]	Light-coloured clay	5½	8
	Blue clay, with 7 inches of stone from 182 feet down, and 4 inches of stone from 191 feet down ...	211	219
	Sandy blue clay	19½	238½
	Loamy clay and white and green sand	1	239½
	Hard dark green sand	6½	246
[Folkestone Beds, 104 feet]	Brown loamy sand	5½	251½
	Hard green sand	1½	253
	Soft brown loamy sand	3	256
	Hard green sandstone	60	316
	Live sand and water...	2	318
	Dark loamy sand and thin veins of clay	32	350

2. Mr. TOPLEY has noted a well, presumably in the village, which proved the Hythe Beds to be 180 feet thick. *Geology of the Weald*, p. 120.

Sutton-at-Hone. HAWLEY MILL, on the Darent.

Ordn. Map 271, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4 (new).

Mr. ARMSTRONG's evidence, in Courts of Justice, January 29th, 1907.

Five wells, three or four of which are pumped from. One is 170 feet deep; the chief one is 100 feet (lined for 37).

Rest-level 2½ feet down. When pump stopped on Saturday 26th the water was about 9 feet; on Sunday 27th at 6 a.m., 3 feet 1 inch, and at 6 p.m. 2 feet 11 inches. When the pumps are not on at the Darenth Pumping Station (about a sixth of a mile eastward, on the other side of the Marsh) the water rises to 9 inches from the surface.

Swanscombe. Messrs. EKMAN'S NORTHFLEET PAPER WORKS.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W. and London and its Environs.

According to Dr. J. C. THRESH there is a shaft to 80 feet, with borings to 200 and 250, and the water-level is about 40 feet down.

I learnt on the spot that the well, all in Chalk, is at the eastern end of the works, and that, with old wells to west, a total of 11,000,000 gallons a week has been pumped.

The works are in an old chalk-pit, the northern part of which was reopened after they were made, with the result noticed on p. 371.

Sydenham, Lower, *see* Lewisham.

Teynham.

CONYER. Water Supply (Faversham Rural Sanitary Authority).

Communicated by Mr. E. EASTON. (*S.E. Naturalist*, 1902.)

Water-level 4¼ feet down.

Shaft, to chalk	12	23 feet
Bore, in chalk	11	

See also **Linsted.**

Thanet, Isle of, *see* Broadstairs, Margate, Minster, Ramsgate, Westgate.

Thanington. CANTERBURY WATERWORKS, 1868.

Ordn. Map 289, new ser.; Geol. Map 3.

Communicated by Mr. S. C. HOMERSHAM.

47 feet above Ordnance Datum.

Sunk 36½ feet, the rest bored. Normal water-level 19 feet below the ground.

Yield, 1,500,000 gallons a day (? tested to).

	Thickness.	Depth.
	Ft.	Ft.
Chalk with flints (with hard chalk below the middle) ... ... about	423	423
Chalk without flints	60	483
Upper Greensand [This must be an error, and the bed most likely a hard gritty bed in the Lower Chalk.]	26½	509½

There are two other bore-holes at the works.

Besides Canterbury the following places are in the area supplied:—Hackington, Harbledown, Sturry and Westbere. The yearly supply is 234,005,893 gallons. (Water Works Directory, 1907.)

Tonbridge or **Tunbridge**.

Ordn. Map 287, new ser.; Geol. Map 6.

1. BARTRAM'S BREWERY.

Made and communicated by Messrs. ISLER & Co.

Lined with perforated tubes, of 6 inches diameter, throughout. Water-level about 13½ feet down. Yield 7,200 gallons an hour. Made ground and gravel, 23½ feet.

2. HILDENBOROUGH. Southwood (Mr. G. Gordon's). 1880?

About 200 feet above Ordnance Datum.

Made and communicated by Messrs. LE GRAND and SUTCLIFF. {Notes by W. TOPLEY, from specimens communicated by Mr. J. LUCAS.} Abandoned without getting any supply Water-level 72 feet down in June, 1880.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Weald Clay]	Coloured clay	15	0	15	0
	Blue clay, with shells, 30⅔ to 31 feet down, and at bottom 2 inches ...	19	8	34	8
	Blue clay and hard light-coloured clay	10	4	45	0
	Blue clay, with shells for 3 inches at top and 2 inches at 58⅔ feet, with 3 inches of claystone at 68 feet {small *Paludina* and ? *Melania* for 2 inches at 74½ feet, *Cyrena* for 2 inches at 84 feet, small *Paludina* at 97 feet}, and with 3 inches of hard claystone at the base ...	75	6	120	6
	Beds of hard and soft blue clay ...	111	3	231	9
	Hard brown clay, with thin beds of stone	4	3	236	0
	Hard clay and shale	115	8	351	8
[? Upper Tunbridge Wells Sand, nearly 87 feet]	Light-coloured [shale ?], with bands of stone	70	4	422	0
	Stone	4	0	426	0
	Hard clay, with thin bands of stone	7	3	433	3
	Hard stone	5	3	438	6
[? Represents Grinstead Clay, 46 feet]	Light-coloured clay, 6 inches, and then soft stone	4	0	442	6
	Soft clay	4	6	447	0
	Hard stone	2	6	449	6
	Hard clay, with stone from 449 feet 10 inches to 452 feet	4	6	454	0
	Hard and soft stone, with clay from 461 to 464½ feet	15	0	469	0
	Hard blue clay	3	2	472	2
	Hard and soft stone	8	4	480	6
	Hard blue clay	4	0	481	6
[? Lower Tunbridge Wells Sand, 62½ feet]	Hard light-coloured stone, with 1 foot 10 inches of clay at the base	22	10	507	4
	Stone, with clay from 518 to 522 feet	18	8	526	0
	Blue clay 2 feet, and then stone ...	13	0	539	0
	Hard clay	2	6	541	6
	Stone	5	6?	547	0

Mr. TOPLEY notes that at Cold Harbour water was got in a well over 300 feet deep.

3. Messrs. WHITE & SONS. 1905.

Bored and communicated by Messrs. ISLER & Co.

Lined with 20 feet of tubes, of 7¼ inches diameter, a foot above the surface.

Water-level 12 feet down. Yield 600 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[? Alluvium]	Brown and grey clay mixed	4	4
[? River Drift]	Hard sand	½	4½
	Brown clay and gravel	4	8½
	Light-brown loamy sand	3	11½
	Sand and ballast	4	15½
[? Tunbridge Wells Sand]	Very light-grey dead sand, almost white when dry	8	23½

4. WATERWORKS. New Wharf, on the western side of the town, south of the Castle. 1852 and on.

From the Waterworks Directory, 1907, and from Mr. JAMES LEES, Engineer to the Company.

About 75½ feet above Ordnance Datum.

Rest-level of water 17 feet down; when pumping 485,000 gallons a day 20 feet. This is the maximum day's consumption (July).

Yearly supply (1907). For domestic purposes 165,039,000 gallons, for trade-purposes 4,500,000, for municipal purposes 1,500,000.

Shallow wells, through Alluvium, about 10 feet thick, to gravel, which averages 10 feet in thickness.

In 1900 the Company bought the race-course (about 53 acres) as a protective area, and it has been found from borings that the gravel is of even thickness over the whole area.

The water is good, though slightly affected after heavy rains and floods: it is therefore mechanically filtered (Bells' process), with very good result.

Besides the town of Tonbridge the following places are supplied:—Hildenborough, Leigh and Shipbourne. The estimated population supplied is 21,300.

This is a unique supply in the county. No other town in Kent getting its water from shallow wells in gravel.

Tovil. ALLNUTT'S PAPER MILL, close to Maidstone.

Ordn. Map 288, new ser.; Geol. Map 6.

F. DREW, *Quart. Journ. Geol. Soc.*, vol. xvii., p. 273, 1861:—"Began at the top of the Weald Clay, passed a water-bearing sand at 115 ft., and went through . . . 600 ft. of clay down to a hard rock . . . which very likely was the top of the Hastings Sand."

Trottersclifffe. RECTORY. 1866.

Ordn. Map 287, new ser.; Geol. Map 6.

"The boring was begun a little below the outcrop of the Gault, and, at a depth of 88 feet, a dark loamy silt was met with, 14 or 15 inches thick; this yielded water. . . . On continuing the bore, more clay was met with . . . to a further depth of 94 feet, when the bore-rod broke. The total thickness of Gault then passed through was 183 feet, with the bottom not reached."—TOPLEY *Geology of the Weald* .p. 148.

Tunbridge Wells.

Ordn. Maps 287, 303 new ser.; Geol. Map 6.

1. CULVERDEN BREWERY. Messrs. Kelsey's. 1906.

Made and communicated by Messrs. ISLER & Co.

		Thickness.	Depth.
		Ft.	Ft.
Well (? old, the rest bored)		—	117
[Tunbridge Wells Sand]	Yellow sand-rock	2	119
	Light-brown sandy rock	3	122
	Light-coloured hard sandy rock ...	29½	151½
	Light-coloured sandstone-rock ...	2½	154
	Light-coloured loamy sand-rock ...	8	162
	Sandstone-rock	6	168
[Wadhurst Clay, 178½ feet]	Loamy hard clay, with rock... ...	10	178
	Light-blue gaulty clay	2	180
	Hard blue gaulty clay	6½	186½
	Hard blue gaulty clay and rock ...	40	226½
	Hard blue clay and rock	13	239½
	Hard blue shaly rock...	27½	267
	Blue clay	1	268
	Hard blue rock	18	286
	Light-blue clay	1	287
	Hard blue rock	18	305
	Light-blue clay and rock	22½	327½
	Very hard rock	4	331½
	Blue clay, with rock	15	346½
[Ashdown Beds]	Hard blue rock	19	365½
	Very hard blue rock	9½	375
	Extra hard rock	28	403

For later information see ADDENDA.

2, GROSVENOR ROAD. Miss Candler's New Laundry.

Boring made and communicated by Messrs. ISLER, 1898.
Lined with 50½ feet of tubes, 7 inches in diameter, 7 inches below surface.
Water-level 46 feet down, in tube. Supply 840 gallons an hour.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Dug well [old] ...	—		52	0
Clay	1	0	53	0
Clay and sandstone	2	0	55	0
Sandstone	4	9	59	9
Clay and sandstone	24	3	84	0
Blue clay	14	0	98	0
Red clay	4	4	102	4
Clay	3	3	105	7

A later account varies somewhat, being as follows (? another well):—

	Thickness.	Depth.
	Ft.	Ft.
Dug well ...	—	48½
Sandstone	7¾	56¼
Sandy clay	25¼	81½
Stone ...	2¼	83¾
Blue clay...	14¼	98
Red clay ...	7¾	105¾

3. HIGH BROOMS LAUNDRY, about 100 yards west of Southborough Station.

Made and communicated by Messrs. MERRYWEATHER.

Water-level 143 feet down. Yield over 1,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
[? Wadhurst Clay]	Yellow clay and gravel Blue clay, with ironstone Blue clay (20 feet) ...	55	55
	Hard blue clay	15	70
	Blue clay and stones ...	23	93
	Hard blue shale	5½	98½
	Shale and rock	4	102½
	Blue and green; some shale	12	114½
	Blue clay	9½	124
	Blue clay and shale... ...	10	134
	Blue clay	10	144
	Blue clay and hard rock ...	6½	150½
	Shale	4½	155
	Blue marl	22½	177½
[Ashdown Sands]	Blue rock and clay... ...	23½	201
	Loamy substance	¾	201¾
	Blue rock	5¼	207
	White sand and sandstone	10	217

4. PROSPECT LODGE (Mr. G. Barnsley-Hughes'). 1898.

Boring, of 6 inches diameter, made and communicated by Messrs. ISLER.

Water-level 20 feet down.

	Thickness.	Depth.
	Ft.	Ft.
Dug well	—	6
Clay	15	21
Sandstone and clay ...	3	24
Sandstone	1½	25½
Clay	25½	51
Clay and Kentish Rag	1	52
Kentish Rag	⅔	52⅔
Kentish Rag and clay	4	56⅔
Clay	9⅓	66
Claystone	4½	70½

[Kentish Rag here means a Wealden stone.]

TUNBRIDGE WELLS WATERWORKS, *see* **Pembury.**

Upchurch.

Ordn. Map 272, new ser.; Geol. Map 6.

1. BURNTWICK ISLAND (? Shiffleet Marsh). 1858.

Boring, communicated by Mr. G. WEBB.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 77 feet]	Clay	5	5
	Sand (muddy)	69	74
	Stones	1	75
	Black clay and rotten peat, with pieces of shell	2	77
[Gravel, 15 feet]	Hard stone gravel	5	82
	Loose shingle (with salt water) ...	10	92
Dark blue London Clay...		37	129
[Oldhaven Beds ?]	Sand	6	135
	Clay and pebbles	2	137
[? Woolwich and Thanet Beds]	Very hard clay...	2	139
	Chalky clay	2	141
	Shells and sand	2	143
	Black clay	2	145
	Running sand, water (not good) ...	7	152
	Sand of various colours	16	168
	Sand and sandstone (red)	3	171
	Muddy sand, varying in colour ...	10	181
	Dark sand	4	185
	Light-coloured sand	6	191
	Live sand, with water	5	196
	Dark sand	5	201
	Sand and loam, with pieces of shell; no water	35	236

2. MILFORD HOPE MARSHES (for Mr. W. Murton. of Tunstall). 1860.

Boring, communicated by Mr. G. WEBB.

Good supply of water found at the bottom.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Black mud	50	50
[Gravel ?]	Shingle	10	60
Coloured [London] Clay		10	70
[Oldhaven, Woolwich, and Thanet Beds]	Dark sand ..	62	132
	Hard stone ..	1	133
	Sand and clay ...	11	144
	Hard stone ...	½	144½
	Loamy greensand	64½	209
	Flints	1	210
Chalk and flints		94	304

Waldershare. Mr. W. C. PAYNE'S.

Ordn. Map 290, new ser.; Geol. Map 3.

Communicated by Mr. G. DOWKER.

Brickearth	3	310 feet
Chalk, with flints	130	
Chalk, without flints, to water	177	

Walmer.

Ordn. Map 290, new ser.; Geol. Map 3.

DEAL AND WALMER WATERWORKS, on the northern side of the road to Mongeham, about a quarter of a mile north of Walmer Station. New well. 1880.

About 119 feet above Ordnance Datum.

Communicated by Mr. W. R. HAMMOND, manager. (*S.E. Naturalist*, 1902.)

Shaft, with adit at the bottom.

Chalk, not firm for 70 feet, 118¾ feet.

There is an old well, 22 feet off, with adits about 149 feet long, from which water had been pumped daily for forty years at the rate of about 200,000 gallons a day.

Early in 1907 the Engineer told me, on the ground, that the adits were 1,450 feet long and about a foot above Ordnance Datum; that the rest-level of the water was about 8 feet above Ordnance Datum, which was pumped down to 3¾ feet; that the highest water-level was reached in February, 1904 (11 feet above Ordnance Datum); and that the main fissures ran about north-west to south-east.

The Works also supply the parishes of Great Mongeham, Ripple, Sholden, and Ringwold.

The yearly supply is 172,206,000 gallons The greatest day's supply 674,000 gallons, in August (Water Works Directory, 1907).

Wateringbury. BREWERY, about 10 chains north of the Railway Station. 1899?

Ordn. Map 288, new ser.; Geol. Map 6.

Communicated by the Rev. G. M. LOVETT.

A boring, starting 6 inches in diameter, 400 feet in Weald Clay. Abandoned.

Westenhanger, *see* Stanford.

Westerham. PUMPING STATION OF THE METROPOLITAN WATER BOARD, at the old Corn Mill on the western side of Squerryes Park, and a little south of the town.

Ordn. Map 287, new ser.; Geol. Map 6.

From the Engineer's Report (W. MORRIS) furnished to the Metropolitan Water Board Arbitrators, 1903.

360 feet above Ordnance Datum.

Shaft 70 feet, with a short heading (? in hard stone), the floor of which is 53 feet down, the rest bored, to 140 feet.

Water-level, September 9th, 1903, when not pumping, about 32 feet down; while pumping, about 48 feet.

All in Lower Greensand.

Dependent on water-power (from the stream). Average supply 25,000 gallons a day.

Westerham Hill Pumping Station is just over the border, in Surrey.

Westgate and Birchington. WATERWORKS, half-a-mile south-west of the Railway Station.

Ordn. Map 274, new ser.; Geol. Map 3.

Shaft and headings in the Chalk, eastward to the road south of Street Lodge, and to a considerable distance south-westward.

West Malling. Phillips' Abbey Brewery, on the northern side of Swan Street, opposite the Abbey. 1898.

Communicated by Messrs. Isler & Co.

Water-level 45 feet down. Supply 3,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Well (? old)	... ...	—	50
[Hythe Beds]	Kentish Rag and sand	9	59
	Kentish Rag	21	80
	White rock and sand	7	87
	Sand	1	88
	Kentish Rag	9	97
[Atherfield Clay]	Sandy clay	28	125
	Brown clay	11	136
	Blue sandy clay ...	8	144

According to Messrs. Le Grand and Sutcliff, the boring was continued in blue [Weald] Clay, with claystones at intervals below 230 feet. Water comes in at 110 feet, supposed to be from the junction of the Hythe Beds and the Atherfield Clay. The water-level varies with working. Monday morning rest-level 40 feet down.

Lined with 50 feet of tubes, of 7¼ inches diameter, 49 feet down.

West Wickham.

Ordn. Map 270, new ser.; Geol. Maps 6, London and its Environs, and London District, Sheet 4.

1. Pumping Station of the Metropolitan Water Board. About half a mile W.S.W. of the Church.

From the Engineer's Report (W. Morris) furnished to the Metropolitan Water Board Arbitrators, 1903.

234 feet above Ordnance Datum.

Well, about 105 feet, and boring 160 feet apart, from centre to centre, connected by a heading a little above the bottom of the shaft. The shaft is bricked in the upper part and then lined with iron cylinders, to about 62 feet.

Original water-level over 51 feet down. Water-level after continuous pumping, September 22nd, 1903, 65 feet.

Supply, subject to seasonal variation, does not exceed 800,000 gallons a day. Another well being sunk.

[Valley Drift]	Yellow clay	3	200 feet
	Stone	4½	
	Rough ballast [Gravel]	3½	
Chalk	... ...	189	

2. Wickham Court.

Quart. Journ. R. Met. Soc. 1885, vol. xi., no. 55, pp. 217, 221, pl. 5.

Sunk in Chalk [with thin cap of Thanet Sand].

A record of the water-level has been kept and the plate shows the average depth of the water from 1866 to 1884, the lowest being in 1875.

Whitstable. WATERWORKS. Two wells.

Ordn. Map 273, new ser.; Geol. Map 3.

The first (1879) sunk and communicated by Messrs. EASTON and ANDERSON

48½ feet above Ordnance Datum.

Shaft 72 feet, the rest bored. Water-level 35 feet down. Yield 220,000 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
Surface soil		4	4
[London Clay, 65 feet]	Stiff yellow clay with joints	22	26
	Blue clay, very liable to slip, with large flakes of micaschist crystals [selenite]	27	53
	Hard sandy clay, quite dry	16	69
[Oldhaven Beds, ? 20 ft.]	Light-coloured sand	19	88
	Bed of stones [flint-pebbles]	1 ?	89
[Woolwich and Thanet Beds]	Sharp sand	14 ?	103
	Green sand	5	108
	Dark sand	40	148
	Loamy sand and stones	20	168
	Blue clay and shells	30	198
	Blue clay	20	218
	Green sand and blue clay	20	238
	Sandstone rock [? flints]	2	240
Chalk		160	400

Possibly the Oldhaven Beds should be taken further down. The thickness of the Lower London Tertiaries (between the London Clay and the Chalk) is excessive.

Another Well. In the yard of the old works, near the Station, ? at a lower level than the foregoing, 1899.

Made and communicated by Messrs. TILLEY.

Surface water-level 11 feet down. Chalk water-level 13½ feet down.

		Thickness.	Depth.
		Ft.	Ft.
Shaft [the rest bored]		—	28
[London] Clay		17	45
[? Oldhaven Beds]	Sand, slightly loamy	18	63
	Black [flint] pebbles	1	64
	Sand	7	71
	Black [flint] pebbles	1	72
	Sand	9	81
	Black [flint] pebbles	1	82
[Woolwich and Thanet Beds]	Hard dark sand	56	138
	Shells and pebbles	1½	139½
	Shells and very hard sand	10	149½
	Dark sand	46	195½
	Sandstone	1	196½
	Clay	18½	215
Chalk and flints		164	379

These works supply also the village of Church Street.

Wickhambreux.

Ordn. Map 289, new ser.; Geol. Map 3.

Abyssinian tube-well, made and communicated by Messrs. LE GRAND and SUTCLIFF.

[River Drift] Gravel	15	40 feet
Chalk and flints ...	25	

Willesborough. WATERWORKS, *see* Hinxhill.

Wilmington. PUMPING STATION OF THE METROPOLITAN WATER BOARD, about a third of a mile N.E. of the Church.

From the Engineer's Report (W. MORRIS) furnished to the Metropolitan Water Board Arbitrators, 1903.

Two wells, 79 feet apart from centre to centre, and a boring 184 feet from one of them, from centre to centre. All connected by headings, a little above the bottom of the wells.

Water-level, with both engines pumping, 29th August, 1903, about 63 feet down. Yield 5,500,000 gallons a day.

No. 1, 28½ feet above Ordnance Datum. Bricked in upper part, then with iron cylinders to 80 feet, 105 feet.

No. 2, 27½ feet above Ordnance Datum. Bricked in upper part, then with iron cylinders to 94 feet, 106 feet.

Made ground (at No. 1) about	6	202 feet
Ballast [River Gravel] „	20	
Chalk	176	

Wingham.

Ordn. Map 289, new ser.; Geol. Map 3.

1. MARGATE WATERWORKS, nearly 1½ miles S. of the Church, on the eastern side of the road to Adisham Railway Station, at the boundary of the parish.

Communicated by Mr. E. A. BORG, Borough Engineer.

130 feet above Ordnance Datum.

Shaft 140 feet in Chalk, with galleries at Ordnance Datum.

Galleries 1,000 yards long, eastward and westward; just a little to the north in each.

Rest-level of water 25 to 27 feet above Ordnance Datum. Level after pumping 20-24 feet above Ordnance Datum.

Tested to 3,000,000 gallons a day.

The following particulars are from the Water Works Directory, 1907:—

Year's supply 382,481,655 gallons. Highest day, in August, 1,444,000.

The following places are in the area of supply:—Adisham, Bekesbourne, Bishopsbourne, Bridge, Chittenden, Dulebourne, Elmstone, Ickham, Knowlton, Monkton, Nonington, Northdown and Garlinge, Preston, Stourmouth, Wickhambreux, Wingham and Womenswold.

Lately an arrangement has been made to supply Broadstairs, so that the yield must increase considerably.—W. W.

2. Messrs. TUFF & MISKIN.

Made and communicated by Messrs. ISLER & Co.

		Thickness.	Depth.
		Ft.	Ft.
Well (? old, the rest bored) ...		—	20
[Thanet Beds]	Grey sand ...	10	30
	Clay and shells ...	14	44
	Green sand ...	18	62

Woodchurch. HIGH VIEW.

Ordn. Map 304, new ser.; Geol. Map 4 or 3.

Communicated by Mr. H. CHESTERMAN, through Mr. C. J. GILBERT. 1903.

Boring.

	Ft.
[Weald] Clay	20
Soft sandstone, with 3 inches of coal (dull and hard) 64 feet down	79

Woodnesborough. SANDWICH and EASTRY WATERWORKS.

Ordn. Map 290, new ser.; Geol. Map 3.

Made and communicated by Messrs. ISLER & Co.

Lined with 100 feet of tubes, of 6 inches diameter.

Water-level 33½ feet down. Yield 450 gallons an hour [from boring].

Well (the rest bored) ...	9½	152 feet
[Thanet Beds] Loamy clay	14	
[Upper] Chalk and flints	128½	

Mr. F. S. COURTNEY gives the following further information:—A well has been made to the depth of 53 feet (1893) at about 53½ feet above Ordnance Datum, and is lined for 25 feet with cast iron cylinders, of 7 feet diameter.

The rest-level of the water is 15 feet down; it is lowered 26 feet by the pumping, and when pumping ceases the rise is rapid. The yield is 30,000 gallons an hour, and the quantity pumped has never exceeded 150,000 in 24 hours. Mr. COURTNEY therefore thinks that the lowering of the water-level at the Ash Brewery (see p. 74) must have been due to some other cause than the pumping at these works.

Some nearer wells, however, have been affected as follows:—

Great Fleming's Farm, more than half a mile W.N.W. of the works, a well about 43 feet deep was made in 1905, with 5 feet of water. In January, 1907, this had not been much affected during the last twelve months.

Ringlemere Farm, about a sixth of a mile from the works, in a like direction, the well, 40 feet deep, has no water in summer.

Another near the works, on the road S.W., 35 to 40 feet deep, is also dry in summer, as would be expected.

Hammill Court, about a mile W. of S.W. of the works, 70 feet deep, said to have been affected in summer.

Hammill, less than a mile S. of S.W. of the works, 77 feet deep. Dry in summer.

Denne Court, about half a mile S.S.W. of the works, 56 feet deep, affected.

The places supplied areAsh, Eastry, Sandwich, Worth, and Woodnesborough.

Another Well. 1908?

Communicated by Messrs. ANSON and SHENTON.

25 feet from the old well, from centre to centre. 52½ feet above Ordnance Datum.

Shaft throughout, with cast iron cylinders for 30 feet. Tunnel (3 feet 10 inches broad), from 45 feet 11 inches to 52 feet 2 inches, 100 feet long.

Connected with the older well by a tunnel with a partition-wall and valve.

Water when first found seemed to flow chiefly from the south-eastern side of the shaft; but afterwards, in making the tunnel, it seemed to come in equally from all directions. The fissures irregular, some horizontal, some vertical, and some at an angle.

Rest-level 16 feet above Ordnance Datum on April 7th, 1908. Tests finished March 27th.

Level of water at start of pumping 7·85 feet above Ordnance Datum.
„ „ cessation „ 3·27 „ „ „ „

Time taken to return to original level after pumping ceased, 3 hours. The slowness of the rise due to the fact that the tunnel had to be filled.

Yield, as found by continuous pumping for 48 hours, 720,000 gallons a day.

		Thickness.	Depth.
		Ft.	Ft.
[Soil]	Loam...	1	1
[Thanet Beds]	Blue loamy sand	9	10
	Yellow loamy sand...	17	27
[Upper Chalk]	Flints, 8 inches and chalk 29 feet	29⅔	56⅔

It was found impossible to empty the well, pumping at the rate recorded. The ordinary town-supply was pumped out of the old well while the test of the new well was going on. The average amount pumped from the old well is 129,000 gallons a day, and when pumping this amount in dry weather the old well is sometimes empty, showing that the minimum yield from the old well is now much less than that recorded above by Mr. Courtney.

Mr. Shenton saw the old well when the water was lowered by pumping, to a level below the top of the bore-tube and he found that a very small quantity of water was coming out of the latter, the old well getting its supply almost wholly from fissures above the bore-hole.

Woolwich.

Ordn. Map 271, new ser.; Geol. Maps 1, S.W., London and its Environs, and London District, Sheet 4 (new).

1-5. Arsenal.

1. Carriage Department Saw-mills (about 1858).

J. Lucas, *Journ. Soc. Arts.*, vol. xxv., p. 607.

Shaft 46¼ feet, bored to 207 feet.

Water-level, after pumping, April 1865, 22 feet down.

2. Laboratory. Paper-factory, facing the entrance-gates. 1856.

22 feet above Ordnance Datum.

18-inch bore; yield 650 gallons a minute.

	Ft.	in.	
To Chalk	5	8	550 feet
In „	544	4	

3. South-western corner of Laboratory Yard. 1861?

Communicated by the Authorities at the Arsenal.

About 30 feet above Ordnance Datum.

Shaft, 51⅓ feet, the rest bored.

Water rose to about 37 feet from the surface. (Not used.)

		Thickness.	Depth.
		Ft.	Ft.
Made ground		1	1½
Sand with gravel (brownish)		6¼	7¾
[Thanet Sand]	Sand	46	53¾
	Bed of flints	¾	54½
Chalk with courses of flints...		311½	366

4, 5. Two borings made and communicated by Messrs. S. F. Baker & Sons. 1854.

Chalk at 101½ and 110½ feet respectively.

6. Dockyard. Saw-mills. 1848.

16 feet above Ordnance Datum.

Shaft 70 feet, the rest bored.

Water-level, 35 feet down before, over 48 after, pumping. Yield 30,540 gallons an hour. (J. LUCAS, *Journ. Soc. Arts.*, vol. xxv., p. 607.)

To Chalk within	20	608 feet
In " ...	588 or more	

A well here (probably the above) bored in chalk, 600 feet deep, yielded 1,000 gallons a minute at a depth of within 70 feet of the surface. (CLARK, in *Proc. Inst. Civ. Eng.*, vol ix., p. 179.)

7. Workhouse.

About 65 feet above Ordnance Datum.

About 70 feet deep, with about 1½ feet of water.

8. In *Water*, vol. vi., no. 63, p. 116, it is stated that a well at the Public Baths, 425 feet deep, yields 31,750 gallons an hour.

Wouldham. WOULDHAM HALL and BURHAM CEMENT WORKS. Messrs. Peters.

Ordn. Map 272, new ser.; Geol. Map 6.

Made and communicated by Messrs. ISLER & Co. (*Rochester Naturalist*, 1901). {Two specimens from Mr. Batchelor.}

Lined with 9 feet of tubes, of 18 inches diameter, from 21 feet down; with 270 feet, of 15½ inches diameter, also from 21 feet down; with 20 feet, of 13 inches diameter perforated, and 20 feet not perforated, from 285½ feet down.

Water-level 18 feet down. Supply 40,000 gallons an hour.

		Thickness.	Depth.
		Ft.	Ft.
Pit (the rest a boring of 15 inches diameter) ...		—	20
Chalk and flints...		26	46
[Gault, 234½ feet]	Gault [Clay]	229	275
	Gault and sand	5½	280½
[Lower Greensand (Folkestone Beds), 72 feet]	Sand	1½	282
	Stone	¾	282¾
	Sand	1	283¾
	Green sand	5¾	289½
	Sandstone	2	291½
	Sand {Specimen grey, sharp, with dark grains, at 310 feet}... ...	14	305
	Sandstone	6½	312
	Grey sand {Specimen lighter-coloured, sharp, with fewer dark grains, at 315 feet}	15½	327½
	Sandstone	3½	331
	Grey sand	10½	341½
	Green sand	6½	348
	Soft grey sandstone, to green sand	4½	352½

Another account makes the Gault clay 209 instead of 229 feet, and all the depths less accordingly.

A note by Mr. TOPLEY, referring to an older well close by, makes the depth to the sand 296 feet and in the sand 38, the water-level being 14 feet above Ordnance Datum.

Wrotham.

Ordn. Map 287, new ser.; Geol. Map 6.

Near Wrotham, at the base of the North Downs.

PRESTWICH, "Water-bearing Strata . . around London," pp. 89, 90 (1851).

Water rose to within 130 feet of the surface.

Chalk	140	266 feet
Blue clay (Gault ?) to sand	126	

Wye. SOUTH EASTERN AGRICULTURAL COLLEGE. 1894?

Ordn. Map 289, new ser.; Geol. Map 3.

About 150 feet above Ordnance Datum.

Journal of the College, No. 1, p. 18 (1895), and communicated by Messrs. DUKE and OCKENDEN, the sinkers.

Water found at 250 feet, rose 10 feet above the ground at the rate of about 8 gallons a minute.

		Thickness.	Depth.
		Ft.	Ft.
[Drift]	Loam and flints	12	12
[Chalk Marl]	Grey marl or chalk	50	62
	Dark sand	3	65
Gault, 185 feet	Blue clay, with carbonate of lime ...	16	81
	Bed full of green sand	5	86
	Blue clay	74	160
	Black clay	51	211
	Sandy rock	1	212
	Black clay with flints [? nodules] in top 10 feet	38	250
[Folkestone Beds]	Green sand	6	256
	Sand ?	10	266

The bore-hole was much choked with sand for some time, until a continuous tube (of 3 inches diameter) was fixed to the depth of 156 feet.

A letter from Mr. E. J. HALSEY (1894) states that there was an old polluted well about 30 feet deep, a little way off, which was closed.

ADDITIONAL NOTE.

Sutton Valence.

Ordn. Map 288, new ser.; Geol. Map 6.

Dr. H. F. PARSONS, in a Report to the Local Government Board on the Hollingbourn Rural District (1886), says that public waterworks were made by a Parochial Committee, the water being pumped from a deep well. Dr. MIVART, in his Report on the same district (1908), notes that these works have been improved and extended; but sanction has been given to their purchase by the Mid Kent Company.

SHAFTS AND TRIAL-BORINGS FOR COAL.

Of the various works done by the different companies or syndicates who have been engaged in exploiting East Kent for coal, more or less detailed accounts have been published in seven cases and short abstracts in four others. The seven are now reproduced and, through the kindness of Prof. DAWKINS, details of the other four are also given, for the first time, thus adding greatly to our knowledge, as, though the latter were not successful in finding Coal Measures, yet in no case has the possibility of the occurrence of that formation been disproved, and in all cases we learn much about the various Secondary formations that have been pierced.

This is not the place to go into the history of the exploration, nor to treat of the various syndicates or associations that have taken up the work; the reader is referred for said history to the many papers by Prof. DAWKINS. Such of these as give details of the borings are noted in the list on p. 364; but besides these he has also written papers descriptive of the work generally, and these may be found in the following journals, &c.:—

Contemporary Review, 1890, pp. 470--478; *Nature*, 1890, vol. 41, pp. 418, 419; vol. 42, pp. 319-322; *Proc. R. Inst.*, 1890; *Trans. Manchester Geol. Soc.*, 1890, vol. xx., pp. 502-517; 1892, vol. xxi., pp. 456--474; 1897, vol. xxv., pp. 155-163; 1906, vol. xxx., pp. 12, 13; *Trans. Fed. Inst. Min. Eng.*, 1894, vol. vii.

There are, of course, papers by other writers, but a full bibliography is not needed here.

I have added an account of another boring, made independently at Newchurch, for a knowledge of which I am indebted to Mr. C. J. GILBERT.

In the following account the various shafts and borings are entered under the parishes to which they rightly belong, other incidental names (from neighbouring hamlets or farms, &c.) being made secondary:—

Alkham, or **Swingfield**. ELLINGE BORING.

Ordn. Map 289, new ser.; Geol. Map 3.
Prof. W. B. DAWKINS. *Final Rep. R. Comm. Coal Supplies*, 1905, pt. x., p. 30.
About 400 feet above Ordnance Datum..

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Chalk, 574 feet]	Upper Chalk	219	10	219	10
	Middle Chalk	117	3	337	1
	Lower Chalk	220	8	557	9
	Glauconitic marl	16	5	574	2
Gault ...	... ...	164	4	738	6
Neocomian, $58\frac{3}{4}$ feet	Lower Greensand	39	1	777	7
	Atherfield Clay	19	8	797	3
Wealden ...	... ...	62	4	859	7
Purbeck ...	... ...	67	7	927	2
Kimeridgian	... ...	189	3	1,116	5
Corallian ...	... ...	153	1	1,269	6
Oxfordian	... ...	198	7	1,468	1
Bathonian	... ...	100	0	1,568	1
Bajocian ...	... ...	54	2	1,622	3
Lias ...	... ...	54	1	1,676	4
Coal Measures.	Dark shales and sandstone	129	4	1,805	8

From the Corallian downward the depth is given as 10 feet more.

This section is notable as showing a thinning of the Lower Greensand, Wealden, and Purbeck Beds, for the presence of the Jurassic Series in various divisions (excepting the Portland Beds), and for the occurrence of Lias.—W.W.

Barham, or **Womenswold.** ROPERSOLE BORING, on the high road between Canterbury and Dover. 1899.

Ordn. Map 289, new ser.; Geol. Map 3.
Prof. W. B. DAWKINS. *Final Rep. R. Comm. Coal Supplies*, 1905, pt. x., p. 29.
400 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Chalk]	Upper Chalk	480	0	480	0
	Middle Chalk	138	0	618	0
	Lower Chalk	200	0	818	0
	Glauconitic marl	16	0	834	0
Gault		119	0	953	0
Lower Greensand, 72 feet	Greensand	51	0	1,004	0
	Atherfield Clay	21	0	1,025	0
Purbeck-Wealden Beds...		55	0	1,080	0
Portland Beds		10	0	1,090	0
Corallian		157	0	1,247	0
Oxfordian and Callovian		142	0	1,389	0
Bathonian and Bajocian		164	0	1,553	0
Liassic		27	9	1,580	9
Coal Measures, 548¼ feet.	Shales and under-clays, with *Calamites*	69	3	1,650	0
	First coal	0	9	1,650	9
	Shales and under-clays, with thin coals and rootlets	51	6	1,702	3
	Second coal, bituminous	0	6	1,702	9
	Shales and under-clays	22	3	1,725	0
	Grey micaceous sandstones... ...	120	8	1,845	8
	Third coal, bituminous	0	5	1,846	1
	Fire-clay, bind and blue shale ...	41	9	1,887	10
	Fourth coal, bituminous	0	4	1,888	2
	Dark carbonaceous shale and bass...	4	8	1,892	10
	Fifth coal, bituminous	–		—	
	Fire-clays, with plants and blue shales	37	10	1,930	8
	Dark micaceous sandstones, with shales and coal-streaks	72	1	2,002	9
	Sixth coal	0	3	2,003	0
	Dark shale	0	3	2,003	3
	Seventh coal	0	5	2,003	8
	Shale and fire-clay	5	9	2,009	5
	Eighth coal	0	2	2,009	7
	Dark shale	0	8	2,010	3
	Ninth coal	0	3	2,010	6
	Dark fire-clay...	6	4	2,016	10
	Tenth coal	0	6	2,017	4
	Dark shale and fire-clay	2	6	2,019	10
	Eleventh coal	0	3	2,020	1
	Fire-clays, micaceous shales, and sandstones	44	5	2,064	6
	Twelfth coal	1	3	2,065	9
	Fire-clay	2	8	2,068	5
	Dark grey shale	19	7	2,088	0
	Grey sandstone, with coal-streaks...	41	0	2,129	0

In an earlier version, in *Rep. Brit. Assoc.* for 1899, p. 735 (1900), there are slight differences, the Middle Chalk being given as 20 feet less and the Lower as 20 feet more; Kimeridge? is put instead of Portland; Bajocian is not inserted, and the Lias is divided (? Upper 3 feet, the rest Middle).

The notable points in this section are as follows:—1. The thinning of the Lower Greensand northward from its outcrop. 2. The still more marked thinning of the great Wealden-Purbeck Series. 3. The presence of various divisions of the great Jurassic Series, with the absence of one of its higher members, the Kimeridge Clay, which is so thick at Pluckley (see p. 235). 4. The occurrence, though in very slight force, of the Lias. 5. The thinness of all the coal-seams found in the 548 feet of Coal Measures passed through, the whole twelve together amounting to but just over 5 feet, one being too thin to be recorded and the thickest being only 15 inches.—W. W.

Brabourne.

Ordn. Map 289, new ser.; Geol. Map 3.

R. Etheridge. The first set of figures from *Rep. Brit. Assoc.* for 1899, p. 733 (1900); the second from a Report to the Kent Collieries Corporation, January 22nd, 1899, quoted in *Final Rep. R. Comm. Coal Supplies*, 1905, pt. x., p. 30. {Words in these brackets from information given by Mr. Etheridge before the section was published.}

322 feet above Ordnance Datum.

Thickness.		Depth.			Thickness.		Depth.	
Ft.	in.	Ft.	in.		Ft.	in.	Ft.	in.
—		—		Superficial deposits... ...	3	8	3	8
72	6	72	6	Gault {very fossiliferous at the base}	68	10	72	6
231	0	303	6	Neocomian {Folkestone Beds, Sandgate Beds, Hythe Beds (thin and *sandy*), and Atherfield Clay}	231	0	303	6
198	0	501	6	Weald Clay	197	0	500	6
206	6	708	0	Hastings Beds	206	2	706	8
14	0	722	0	Portlandian	14	0	720	8
242	0	964	0	Kimeridge Clay	242	4	963	0
305	0	1,269	0	Corallian	305	4	1,268	4
243	0	1,512	0	Oxfordian {Kellaways present, but fossils rare} ...	243	8	1,512	0
189	1	1,701	1	Bathonian	189	8	1,701	8
74	8	1,775	9	Middle Lias	74	8	1,776	4
98	1	1,873	10	Lower Lias	97	1	1,873	5
48	4	1,922	2	Dolomitic Conglomerate (Trias) {red and grey sandy marls, coarse conglomerate}	48	0	1,921	5
88	5	2,010	7	Devonian or Old Red Sandstone {dark grey, dense, clayey rock}	82	7	2,004	0

The last two depths in the first set of figures are given as 1,936 feet 2 inches and 2,024 feet 7 inches.

The points of interest in this section are:—1. The thinning of the Weald Clay only a few miles from its outcrop. 2. The occurrence of various divisions of the Jurassic Beds, some in considerable force. 3. The presence of a fair amount of Lias. 4. The occurrence of that peculiar bed the Dolomitic Conglomerate, next above the older rocks, and to the evidence of there being Carboniferous Limestone somewhere in the district, as pebbles of that rock form part of the Conglomerate. This is the only certain occurrence of Trias in Kent.—W. W.

Coldred. The WALDERSHARE BORING. About three-eighths of a mile N.N.E. of the Church, near the western edge of Waldershare Park. 1907.

Ordn. Map 290, new ser.; Geol. Map 3.

Prof. W. B. DAWKINS, *Journ. Soc. Arts*, vol. lv., no. 2,833, pp. 456, 7.

325 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Chalk and chloritic marl		820	0	820	0
Gault		156	0	976	0
Lower Greensand		70	0	1,046	0
Purbeck-Wealden		42	0	1,088	0
Oolites		301	0	1,389	0
Lias		5	0	1,394	0
Coal Measures.	Thick coarse sandstones, with many pebbles of coal, sometimes forming a conglomerate; subordinate layers of bind-shale and underclays, and occasional nodules of clay-ironstone	349	0	1,743	0
	Binds (claystones), shales and underclays, with a thin layer of sandstone...	73	11	1,816	11
	First coal, blazing	1	8	1,818	7
	Fire-clay	6	8	1,825	3
	Bind	52	9	1,878	0
	Second coal, blazing...	3	4	1,881	4
	Fire-clay	5	10	1,887	2
	Bind	16	1	1,903	3
	Third coal, blazing	4	6	1,907	9
	Fire-clay	2	3	1,910	0
	Bind	44	4	1,954	4
	Fourth coal	1	4	1,955	8
	Fire-clay passing into bind... ...	5	2	1,960	10
	Fine grey sandstones and binds, in equal proportions	282	3	2,243	1

From below 1,887 ft. 2 in. the depths are given a foot in excess.
This boring shows thicker coals than the others.

Dover Colliery, *see* **Hougham.**

Elham. OTTINGE BORING. Begun May, 1898, ended October, 1899.

Ordn. Map 289, new ser.; Geol. Map 3.

Prof. W. B. DAWKINS, *Final Rep. R. Comm. Coal Supplies*, pt. x., p. 30. The details below the Gault from the MS. of Prof. DAWKINS, by whom the site was selected and the work supervised.

300 feet above Ordnance Datum.

There are specimens in the Museum at Owen's College, Manchester.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Lower Chalk]	Grey chalk	170	0	170	0
	Glauconitic marl	5	0	175	0
Gault		127	0	302	0
[? Folkestone Sandgate and Hythe Beds]	Running sand, with glauconitic grains	16	0	318	0
	Hard cherty greensand	1	0	319	0
	Greensand	7	9	326	9
	Greensand with hard cherty and calcareous beds	40	3	367	0
	Greensand with hard beds	9	0	376	0
	Hard cherty Rag, calcareous	1	1	377	1
	Loose greensand	5	1	382	2
	Hard green sandstone	1	2	383	4
	Loose greensand	9	6	392	10
	Hard calcareous green sandstone. Rag	0	9	393	7
	Softer green sandstone	3	0	396	7
	Hard green sandstone. Rag	1	7	398	2
	Green sandstone. Rag	5	10	404	0
Atherfield Clay, 111 feet	Dark brown sandy clay	26	0	430	0
	Dark brown clay	26	0	456	0
	Blue and dark brown clays. *Pinna tetragona*	59	0	515	0
Wealden, 195¾ feet ?	Grey clay. *Cyrena* and plants	24	0	539	0
	Fine white shale	1	0	540	0
	Dark grey clay, the bottom 5 feet with lignite and pyrites	88	0	628	0
	Brown sandy clay. Lignite and plants	17	0	645	0
	Brown clay with layers of lignite. *Equisetum* [*Equisitites*]	30	0	675	0
	Sandy shale	5	0	680	0
	Dark sandstone	1	0	681	0
	Grey clay with hard calcareous beds or nodules, false-bedded. Plants	19	0	700	0
	Dark hard sand	1	0	701	0
	Brown sandy clay	2	0	703	0
	Hard grey clay with hard calcareous beds or nodules, false-bedded	7	9	710	9
Portlandian, 17¼ feet	Hard calcareous sandstone, grey, with green grains	1	3	712	0
	Grey sand with green grains	10	0	722	0
	Hard calcareous grey sandstone, with green grains, shelly (*Exogyra nana*, *Ostrea expansa*, *Pecten lamellosus* and *nitescens*, *Trigonia gibbosa* ?)	6	0	728	0
Kimeridgian, 108½ feet	Dark hard clay, with fossils (*a*)	12	0	740	0
	Dark marl, with fossils (*b*)	6	0	746	0
	Hard clay	2	0	748	0
	Compact grey clay, with fossils (c)	7	0	755	0
	Grey shale, with fossils (*d*)	20	0	775	0
	Shelly calcareous rubbly stone, with fossils (*e*)	2	0	777	0
	Grey clays and marls. *Alaria*, *Lingula ovalis*	48	0	825	0
	Grey clay. *Alaria*	10	0	835	0
	Compact shelly sandy limestone	1	6	836	6

Besides the fossils named above Prof. DAWKINS also notes the following from the Kimeridgian, from the beds marked *a* to *e* :--

Ammonites biplex, *Sow.* [Holcostephanus pallasianus, *D'Orb.*], *a*, *b*, *c*, *d*, *e*.
Ammonites triplex, *Sow* (? trifidus), *d*.
Alaria trifida, *Phil.* *c*.
Littorina [muricata, *Sow.* var.] pulcherrima, *Dollf.* *d*.
Arca rhomboidalis, *Contej.* *b*, *d*.
Astarte mysis, *D'Orb.* *a*, *c*, *d*, *e*.
Cardium striatulum, *Sow.* *a*, *c*, *d*, *e*.
Exogyra virgula, *Defr.* *d*.
Modiola semiplicata, *Buv.* *b*, *c*.
Nucula Menkii, *Roem.* *c*.
Ostrea deltoidea, *Sow.* *a*.
Ostrea expansa, *Sow.*
Pecten lens, *a*.
Perna mytiloides, *Lam.* *d*, *e*.
Thracia depressa, *Sow.* *d*, *e*.
Trigonia Woodwardi, *Lyc*, *c*, *d*.
Trigonia, *a*.
Lingula ovalis, *Sow.* *b*, *c*, *d*, *e*.

Ellinge Boring, *see* Alkham.

Fredville Boring, *see* Nonington.

Hothfield. Begun July, 1898, ended October, 1899. Just west of Parsonage Farm, a little southward of Hothfield Station (? in Westwell Parish).

Ordn. Map 289, new ser.; Geol. Map, 3.

From the MS. of Prof. W. B. DAWKINS, by whom the site was selected and the work supervised. Only a very short abstract published.

About 200 feet above Ordnance Datum.

There are specimens in the Museum at Owen's College, Manchester.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Lower Greensand	Folkestone Beds ... ... Sandgate Beds ... ... Hythe Beds (Kentish Rag) ...	156	0	156	0
	Atherfield Clay	24	0	180	0
[Weald Clay]	Stiff blue sandy clay, with hard calcareous nodules. *Cypridea, Cyrena media, Melania, Paludina* ...	267	0	447	0
	Paludina-marble, earthy	0	3	447	3
	Stiff blue sandy clay...	19	9	467	0
	Paludina-marble	0	3	467	3
	Stiff blue sandy clay	17	9	485	0
	Red and tea-green mottled clays ...	15	0	500	0
	Sandy red and green mottled clays	13	0	513	0
	Blue and grey clay	67	0	580	0
	White hard sand	17	0	597	0
Wealden (and Purbeck) Beds	Light-grey clay with pyrites. *Lepidotus*...	62	0	659	0
	Hard sand	0	6	659	6
	Light-grey clay	4	6	664	0
	Sandy clay. Plants (? 18 inches) Irregular bed of sand-nodules. Plants	2	0	666	0

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Wealden (and Purbeck) Beds	Sandy clay	18	0	684	0
	Fine white loam. Plants	5	0	689	0
	Brown and purple clay	2	0	691	0
	Coarse yellow sandstone	1	6	692	6
	White and grey mottled loams. Plants	4	6	697	0
	White sand	3	0	700	0
	Dark clay with iron-pyrites and calcareous bands. Slickensides. Plants	24	0	724	0
	Dark green clay	4	0	728	0
	Green sandy rock	0	6	728	6
	Green sandy clay	0	6	729	0
	Green clay and white breccia ...	4	6	733	6
	Compact white limestone	1	0	734	6
	Light-green clay	0	6	735	0
	Light-grey clay	5	0	740	0
	Grey calcareous sandstone	0	7	740	7
	Calcareous tea-green marls... ...	4	0	744	7
	Hard dark clay. Slickensides ...	1	9	746	4
	Compact white limestone	0	8	747	0
	Grey and white limestone, compact, veined	2	0	749	0
	Dark and light-coloured clays and breccia	2	0	751	0
	Green marl. Lignite...	1	0	752	0
	Hard green marlstone	0	3	752	3
	Green marlstone, with white breccia and pebbles...	3	9	756	0
	Dark grey clay	10	0	766	0
	Green clay, with angular fragments and pebbles of white limestone. *Cypridea*	2	0	768	6
	Hard green marl	0	6	768	0
	Soft grey clay...	1	0	769	6
	Hard calcareous green marl, with black grains. *Cypridea*, fish ...	0	6	770	0
	Grey marls	1	6	771	6
	Hard grey marlstone, with pyrites...	0	6	772	0
	Alternate bands of hard grey marlstone and soft green shale ...	1	0	773	0
	Grey marlstone. Plates of Echinoderm, vertebræ of fish	2	9	775	9
	Dark shale, with pyrites and green grains. *Ostrea*	1	0	776	9
	Blue sandy shale	3	3	780	0
	Grey laminated earthy limestone. Lignite	1	0	781	0
	Dark calcareous shale	4	0	785	0
	Grey laminated limestone, with soft particles of clay	3	0	788	0
	Blue calcareous shale	2	0	790	0
	Grey laminated limestone	2	0	792	0
Portlandian	Sandy calcareous grey and green limestone, with particles of clay and green grains. *Serpula intestinalis*, *Cliona*, *Exogyra nana*, *Pecten lamellosus*, *Trigonia* ...	7	0	799	0
	Green-grey calcareous sand, with lignite	10	0	809	0

Hougham. Dover Collieries, by the Tunnel-mouth westward of Shakespeare's Cliff.

Ordn. Map 306, new ser.; Geol. Map 3.

There were in 1898 four borings or shafts in line and about equi-distant, beginning on the east with the Channel Tunnel shaft, next coming the deep trial-boring, then No. 2 pit (Simpson), and lastly No. 1 pit (Brady). The following accounts are summarised from a section by R. Etheridge, *Final Rep. R. Comm. Coal Supplies*, 1905, pt. ix., pp. 46, 47.

No. 1 Pit:—		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Recent]	Loose chalk talus	40	0	40	0
	Beach	18	11	58	11
Chalk	Chalk	99	6	158	5
	Chloritic marl...	7	4	165	9
Gault, 136¾ feet.	Grey clay, with fossils	97	2	262	11
	Clay	38	5	301	4
	Sandstone	1	2	302	6
Lower Greensand, 123⅔ feet.	Folkestone Beds. Greensand-rock and dark green sand, with *Pholadomya*	44	0	346	6
	Sandgate Beds and Hythe Beds. Dark clay and green sand or sandy clay	38	4	384	10
	[Atherfield Clay] Green-grey and brown clay, with fossils	41	4	426	2
Wealden Beds	[Weald Clay]. Clays with *Unio* in upper part, *Paludina* and *Cypris* in lower ...	50	4	476	6
[? Hastings Beds]	Lignite...	1	6	478	0
	Pale green and white silt and sand	14	10	492	10
	Brown and white clay with lignite	13	4	506	2
	Sand and gravel (water)	4	0	510	2
	White clay	5	0	515	2
	Gravel and sand	2	6	517	8
	Soft dark green clay...	2	0	519	8

Simpson's Pit. No. 2:—		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Not described	[Chalk, Gault and Lower Greensand?]	—		330	0
Lower Greensand, 103 ft. 2 in.	Sandgate Beds and Hythe Beds. Dark green sand and sandy clay	58	4	388	4
	Atherfield Clay. Dark sandy clay and blue or brown clay	44	10	433	2
Wealden Beds, 86 ft. 10 in.	Weald Clay. Soft grey and dark shaly clay with bands of clayey ironstone	41	7½	474	9
	Hastings Beds. Soft grey clay and sand	45	2½	520	0
Kimeridge Clay.	Alternations of limestone and clay	34	2	554	2

Simpson's Pit. No. 2:—			Thickness.		Depth.	
			Ft.	in.	Ft.	in.
Corallian, 204 ft. 10 in. [given as 1 ft. more, the depths, after 700 ft. 2 in., being given a foot in excess]		Sandy clay and limestone	6	4	560	6
		Oolitic limestone and calcareous grit	14	0	574	6
		Brown sandstones, shelly clays and limestones	11	10	586	4
	Ironstone Bed	Grey marly clay with grains of ironstone...	0	6	586	10
		Brown clay with band of ironstone... ...	1	0	587	10
		Grey marly clay ...	2	0	589	10
		Hard white limestone	0	6	590	4
		Limestone with clay partings	2	0	592	4
		Ironstone-beds ...	16	10	609	2
		Hard crystalline limestone... ...	0	3	609	5
		Clay, with shells	6	11	616	4
		Clay and flaggy limestone	29	11	646	3
		Marly bed with many shells ...	13	9	660	0
		White coral-débris	17	2	677	2
		White fossiliferous semi-crystalline beds	20	5	697	7
		Limestone with fossils	2	7	700	2
		Grey and white limestone and beds not described	36	10	737	0
		Impure limestone with fossils (Transition-bed)	22	0	759	0
Oxford Clay, 182 ft. 1 in.		Grey marl and limestones, with fossils	43	3	802	3
		Clay and oolite	8	9	811	0
		Clay and shale	13	0	824	0
		Oolitic clay, with fossils	5	3	829	3
		Clay, etc.	6	0	835	3
		Clay, with fossils in top 23¾ feet, and from 877 to 926 feet (*Cordatus* beds at 885 to 919)...	90	9	926	0
		Clay and oolitic rock	15	1	941	1
Kellaways Rock [and Lower Oolites] 177 ft. 11 in.		Clay and oolitic rock, with fossils...	13	9	954	10
		Oolitic rock and dark sandy beds, with fossils	37	3	992	1
		Dark grey siliceo-calcareous bed ...	8	0	1,000	1
		Oolitic clay and clayey rock. Limestone, with *Ostrea*...	18	11	1,019	0
		Lignite with part of a large coniferous tree-stem	4	0	1,023	0
		Dark and grey oolite	4	11	1,027	11
		White oolite-like fine-grained stone and clayey limestone	28	1	1,056	0
		Oolitic limestone, with fossil ...	3	0	1,059	0
		Hard grey limestone and calcareous grit	44	9	1,103	9
		Sand or sandstone	15	3	1,119	0
Lias, 37 feet.		Alternations of clay and limestone	16	10	1,135	10
		Dark grey clay and marl	20	2	1,156	0
[Coal Measures, 6 ft. 10 in.]		Clay, shale and bind...	23	6	1,179	6
		Coal-seam, denuded, divided by a thin sandy seam	2	6	1,182	0
		Under-clay, rich in coal-plants ...	6	0	1,188	0
		Sandstone, with thin coal-streak ...	2	6	1,190	6
		Shale, a thin seam of coal at 1,198 [? 1,197] feet	26	4	1,216	10

Below 1,179½ feet another foot is added to the column of depths in the original, so that, with that added in the Corallian, the total is made 2 feet more than the above.

For the names of the fossils found in the various beds the reader is referred to the Report.

As the above gives details down to the Coal Measures, which could be better made out from a shaft than from a boring, there is no need to reproduce those given by Prof. DAWKINS, from specimens brought up from the trial-boring; but inasmuch as this has been carried much deeper than the shaft has reached, it is well to reproduce the details of the Coal Measures that he has given, from p. 28 of the *Final Rep. R. Comm. Coal Supplies*, pt. x., p. 28. The level of the site is about 54 feet above Ordnance Datum, and the Coal Measures were reached 1,100½ feet below that level, which figures agree closely with the 1,156 feet given as the depth to the Coal Measures in the shaft.

Prof. DAWKINS' section is as follows :—

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Coal Measures, with a dip of only 2°	Shales, sandstones and blue bind (*Calamites*) ...	24	6	1,180	(say)
	First coal, bright and bituminous ...	1	3	1,181	3
	Sandstone ...	1	0	1,182	3
	Second coal, good house-coal ...	1	3	1,183	6
	Carbonaceous clays, sandstones and shale...	59	6	1,243	0
	Third coal ...	0	6	1,243	6
	Sandstone ...	29	0	1,272	6
	Fourth coal, good, blazing, with specks of iron-pyrites ...	2	0	1,274	6
	Underclay ...	1	6	1,276	0
	Shale and blue bind ...	44	6	1,320	6
	Fifth coal, good, blazing, with specks of iron-pyrites ...	2	0	1,322	6
	Blue bind and sandstone ...	30	9	1,353	3
	Sixth coal, bituminous ...	1	3	1,354	6
	Shale, bind, sandstone ...	155	6	1,510	0
	Fire-clay with traces of coal ...	6	0	1,516	0
	Seventh coal ...	1	0	1,517	0
	Carbonaceous sandstone with carbonaceous streaks and bind ...	23	0	1,540	0
	Eighth coal, good house-coal ...	2	6	1,542	6
	Fire-clay, bind, sandstones, with a four-inch seam of coal ...	111	6	1,654	0
	Ninth coal ...	2	3	1,656	3
	Grey sandstone and bind ... Massive bedded carbonaceous ...	191	6	1,847	9
	Tenth coal, coking ...	2	9	1,850	6
	Hard underclay ...	5	6	1,856	0
	Dark grey sandstone and bind ...	60	0	1,916	0
	Eleventh coal...	1	8	1,917	8
	Hard underclay ...	3	4	1,921	0
	Hard dark sandstones ... Shales, carbonaceous, with plants	203	8	2,124	8
	Twelfth coal, hard ...	1	0	—	
	Grey sandstones, blue bind, and black shales...	134	6	2,259	2
	Thirteenth coal, bituminous ...	4	0	2,263	2
	Hard grey carbonaceous sandstones	104	6	2,307	8
	Bind ...	0	6	2,308	2

Unfortunately, the figures of depths (below Ordnance Datum) in the original do not altogether agree with those for thicknesses.

Prof. DAWKINS' earlier account of the boring (*Trans. Manchester Geol. Soc.*, vol. xxii., pp. 489—493) gives fuller details; but the above is ample for the present purpose.

The following particulars of an outburst of water at the Dover Colliery are from an official paper, a "Report on the Inspection of Mines . . . in . . . Kent,"* in which a very full account is given, for a knowledge of which I am indebted to Prof. DAWKINS. The water comes from the Lower Greensand:—

"On the 6th of March [1897], . . . when 14 men were at work in the bottom of No. 2 Pit (Simpson), sinking, water broke in, lifting the bottom, and so rapidly rising that the men had to climb the iron rings within the timber which lined the shaft for 40 feet. The hoppet was at the pit top being emptied, the cries of the men were heard, quickly was the hoppet lowered, and on being raised three men were brought out. . . . Again was the hoppet lowered . . . on being raised three more men were brought out. . . . Again the hoppet was lowered, containing one of the master sinkers and one of the rescued. . . . They descended to the surface of the water and carefully examined in the hope others might be rescued, but none could be seen. The water had risen about 80 feet up the shaft, so that of the 14 men at work only 6 escaped. . . ."

"In the fearful struggle for life all were bruised and received contusions, one poor man was unconscious on arrival at the top. . . ."

"On the following day the only available means for getting out the water was put in operation, a water barrel holding 400 gallons to draw the water." It is strange that when dealing with such a formation as the Lower Greensand no pump had been provided, but apparently the opinion of a geologist had not been taken, or at all events not acted on.

The verdict of the jury spoke of "the inrush of water having, in the first instance, come from the bore-hole, and that thereupon the water from the Brady Pit sought its level by entering the Simpson Pit."

From evidence given we learn that the shaft was 303 feet deep at the time, and apparently just through the Gault.

According to the manager, Mr. A. REID, "the temperature of the water averaged 72 degrees Fahrenheit. This was either due to the fact that the water came from a great depth or from chemical action." He thought that the former was the explanation. "The water was charged with fire-damp, which lit again and again when a candle was put near. We have arrived at the conclusion that it comes from a great depth, probably 1,200 feet, that it is a feeder of about 50,000 gallons per hour."

It is curious, however, that at the depth specified the work is in Coal Measures, of a fairly impermeable character.

We are also told that "the Brady Pit, or No. 1 shaft, 17 feet diameter was carried to a depth of 366 feet, it was stopped on October 16th, 1896, by an influx of water there being no adequate appliances for raising water." One may therefore accept Mr. GERRARD'S opinion that "undoubtedly these lives might have been saved, and the progress of the work greatly developed, had it been foreseen that pumping appliances would be required. Further it would have been to the distinct advantage of all concerned, had some of the energy which had been displayed in Stock Exchange developments, been devoted to the establishment of fitting plant, after the need for the same was so clearly demonstrated, in October, 1896." A shaft has since been successfully carried down to coal.

The rest-level of the water in No. 1 shaft was 40 feet down. Remarks on the character of the water are given further on, p. 321.

Newchurch *see* Ruckinge.

Nonington. THE FREDVILLE BORING, close to the Railway.

1907.

Prof. W. B. DAWKINS. *Journ. Soc. Arts*, vol. lv., no. 2,833, p. 457.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Chalk and chloritic marl	860 [800]	0	860 [800]	0
Gault	148	0	948	0
Lower Greensand	51	0	999	0

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* Reports of John Gerrard, Esq., H.M. Inspector of Mines. Fol., *London*, 1898, pp. 15-20.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Purbeck-Wealden	... ...	36	0	1,035	0
Oolites ...	... ...	323	0	1,358	0
Lias ...	... ...	10	6	1,368	6
Coal Measures, dip 17°	Shales and binds, with a 10-feet bed of sandstone...	37	6	1,402	0
		[34]			
	Bind	21	0	1,423	0
	First coal, hard but blazing... ...	1	6	1,424	6
	Fire-clay	3	0	1,427	6
	Shale and bind	17	9	1,445	3
	Second coal, hard, blazing	1	6	1,446	9
	Fire-clay	0	6	1,447	3
	Shale	1	6	1,448	9
	Bind	9	2	1,458	0
			[3]		
	Grey sandy bind, with subordinate layers of sandstone	41	0	1,499	0
	Grey bind	2	5	1,501	5
	Dark shale	0	1	1,501	6
	Third coal, bituminous	4	4	1,505	10

Old Soar, *see* Wrotham.

Ottinge, *see* Elham.

Penshurst. Begun August, 1897, ended February, 1899.
For the Mid Kent Coal Company.

Ordn. Map 287, new ser.; Geol. Map 6.

About 90 feet above Ordnance Datum.

From the MS. of Prof. W. B. DAWKINS, who supervised the work. There are specimens in the Museum of Owen's College, Manchester.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil ...	... ...	1	0	1	0
Wealden-Purbeck Beds, down to 1,114 feet 4 inches	Grey sandstone	24	0	25	0
	Blue shale	2	0	27	0
	Grey sandstone, with shales ...	10	7	37	7
	Grey sandy shale	8	0	45	7
	Grey sandstone	1	6	47	1
	Grey sandy marl	13	9	60	10
	Grey sandstone	3	0	63	10
	Grey sandy marl	3	0	66	10
	Grey sandstone	3	3	70	1
	Red and grey marl	8	0	78	1
	Grey sandy marl	4	0	82	1
	Grey sandstone, with marls... ...	3	6	85	7
	Dark grey and red marl	10	5	96	0
	Grey sandstone	3	8	99	8
	Dark grey and red marls	3	4	103	0
	Grey sandstone	3	8	106	8
	Grey marl	5	3	111	11
	Grey sandstone	14	3	126	2

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Wealden-Purbeck Beds, down to 1,114 feet 4 inches	Grey sandy marl	4	6	130	8
	Grey sandstone	3	0	133	8
	Grey sandy marl	1	0	134	8
	Red and grey marl	16	11	151	7
	Alternations of grey marls, shales, and sandstones	20	0	171	7
	Grey sandstone	10	3	181	10
	Alternations of grey marls and sandstones	31	6	213	4
	Green and grey sandstone	5	0	218	4
	Alternations of grey marls and sandstones. Carbonaceous streaks	74	11	293	3
	Grey sandstone. Carbonaceous streaks	42	1	335	4
	Alternate grey marls and sandstones, with lignite	23	10	359	2
	Grey sandstone	9	10	369	0
	Grey sandy marls and sandstones	17	7	386	7
	Grey and green sandy marl	11	10	398	5
	Alternation of grey marls and sandstones	17	2	415	7
	Alternation of grey and green marls and sandstones	13	1	428	8
	Blue marl	3	8	432	4
	Grey marls and sandstones	22	0	454	4
	Blue sandy marl	0	3	454	7
	Grey sandstones and subordinate marls	6	3	460	10
	Blue and grey sandy shale	5	2	466	0
	Grey sandstone	0	5	466	5
	Dark grey sandy shale. Plants	10	5	476	10
	Blue shale	1	8	478	6
	Grey and green sandy shale. Carbonaceous lines	12	11	491	5
	Green and grey shales	2	11	494	4
	Green and grey sandy shales. Ironstone-nodules	6	0	500	4
	Grey shale	1	6	501	10
	Grey sandstone	2	10	504	8
	Brown and grey sandy shale	1	6	506	2
	Grey sandstone. Plants	1	0	507	2
	Dark grey shale, with layers of crushed shells. *Unio valdensis*	5	1	512	3
	Dark grey shale. Ironstone-nodules	3	1	515	4
	Green shale	1	8	517	0
	Dark grey shale. *Cypridea faba*, *Cyrena media* and *membranacea*, *Unio antiquus* and *compressus*, *Melania*, *Paludina fluviorum*	5	0	522	0
	Dark sandy shale	7	8	529	8
	Grey and green shale. Ironstone-nodules. Plants. *Cypridea faba*, *Cyrena media*, *Unio valdensis*, *Paludina fluviorum*, *Lepidotus*. Teeth of fishes and reptiles	10	2	539	10
	Dark grey shale	5	5	545	3
	Grey sandstone. Carbonaceous lines	6	10	552	1
	Grey and green shales. Ironstone-nodules and fossils	5	0	557	1

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Wealden-Purbeck Beds, down to 1,114 feet 4 inches	Grey, blue, and green shales ...	5	8	562	9
	Grey and green shaly sandstones ...	5	10	568	7
	Grey shale. Ironstone-nodules ...	2	0	570	7
	Black, green, and grey shales. Ironstone-nodules and shells	6	5	577	0
	Grey sandstones, with shale ...	6	11	583	11
	Grey calcareous shale. Shells ...	1	3	585	2
	Dark grey shale. Ironstone-nodules	0	7	585	9
	Grey and green shales. *Equisetites Lyelli*, *Cypridea faba*, *Cyrena media* and *membranacea*, *Unio antiquus*, *Paludina fluviorum* ...	12	3	598	0
	Grey and green shales. Ironstone-nodules. *Cyrena media*, ganoid scales	17	2	615	2
	Grey and green shaly sandstone ...	5	2	620	4
	Dark grey and green shale. Ironstone-nodules. *Cypridea faba*, *Cyrena membranacea*	11	6	631	10
	Grey sandstone	0	6	632	4
	Alternations of dark grey and green shales. Ironstone-nodules. *Equisetites Lyelli*, *Cyrena media* and *membranacea*, *Planorbis Jugleri* ?	25	7	657	11
	Grey sandy shale	3	3	661	2
	Green marl	1	6	662	8
	Dark grey shale, with shells ...	2	10	665	6
	Dark grey shaly sandstone	8	3	673	9
	Dark grey shale, very fossiliferous. Ironstone-nodules. *Cyrena media* and *membranacea*, *Unio antiquus*...	33	2	706	11
	Green marl, with crushed shells ...	5	3	712	2
	Grey sandy shale, with shells ...	2	3	714	5
	Dark grey shale, with shells ...	4	2	718	7
	Green marl, with shells. Ironstone-nodules	4	5	723	0
	Grey shale, with thin limestones. *Cyrena media*	25	6	748	6
	Green marl	1	4	749	10
	Grey sandstone	2	0	751	10
	Dark sandy shales, with thin limestones. *Cyrena media*	15	6	767	4
	Grey sandy shale	8	8	776	0
	Grey shale, green marl, and lignite	3	10	779	10
	Dark brown sandy shale	2	2	782	0
	Green marl	3	8	785	8
	Dark grey shale, with shells ...	2	3	787	11
	Green and grey marl...	1	3	789	2
	Grey ironstone	1	10	791	0
	Grey sandy shale. Ironstone-nodules	7	11	798	11
	Green sandy marl	2	5	801	4
	Grey limestone	1	0	802	4
	Black and green shale, with shells Dark grey shales. Ironstone. *Cyrena media*, *Ostrea distorta*, *Unio*	11	4	813	8
	Grey sandstone and marl. Ferns...	3	6	817	2
	Dark grey marlstone, with thin limestone and black shales. Ironstone-nodules. *Cyrena media*, *Ostrea distorta*, *Melania*	12	6	829	8

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Wealden-Purbeck Beds, down to 1,114 feet 4 inches.	Dark grey shale, with shells. Ironstone-nodules	12	9	842	5
	Grey limestone	1	7	844	0
	Grey marl, with shells	6	8	850	8
	Black shale, with shells	5	0	855	8
	Grey shales	15	11	871	7
	Grey and green marls, with thin limestones (up to 2¼ feet thick). Ironstone-nodules, layers of fresh-water-shells. *Ostrea*	68	11	940	6
	Grey sandy marl, with a thin layer of gypsum	21	6	962	0
	Grey sandy marl, with thin limestones	29	6	991	6
	Compact grey limestone, with oolitic grains, fragments of bivalve-shells, perfect small *Paludinæ* and *Cypridea*	1	4	992	10
	Grey and green calcareous marls. Gypsum	43	9	1,036	7
	Black shale. Gypsum	11	9	1,048	4
	Grey limestone	0	7	1,048	11
	Black shales. Abundance of gypsum; ironstone-nodules	65	5	1,114	4
Portlandian, 116⅔ feet	Black calcareous shales. *Ostrea læviuscula* ?...	5	8	1,120	0
	Black calcareous marls. *Pecten lamellosus*, *Perna Bouchardi*? ...	25	0	1,145	0
	Fine grey sandstones and sandy shales	86	0	1,231	0
Kimeridgian	Black or dark shales, with fossils ...	636	0	1,867	0

Prof. DAWKINS notes the following fossils from the Kimeridgian :—

Ammonites biplex [Holcostephanus, cf. pallasianus *D'Orb*].
Ammonites triplex [? trifidus].
Belemnites.
Littorina [muricata, var.] pulcherrima.
Arca.
Astarte mysis.
Astarte ovalis [? ovata].
Cardium striatulum.
Ostrea læoviuscula.
Pecten [lens, var.] Morini.
Trigonia Woodwardi.
Discina Humphriesiana.
Discina latissima.
Lingula ovalis.
Plants.

Pluckley. On the northern side of the Railway, a little east of the Station.

Ordn. Map 288 new ser.; Geol. Map 3.

Summarised from a section by R. ETHERIDGE. *Final Rep. Roy. Comm. Coal Supplies*, 1905, part ix., p. 48.

About 105 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Weald Clay	Dug, for the engine	—		14	6
	Mottled clay	4	6	19	0
	Yellow, brown and grey clays ...	104	6	123	6
	Red and mottled clay	140	6	264	0
	Grey marl, pale and soft	206	2	470	2
	Stiff clay, rich in *Ostracoda* ...	0	4	170	6
	Lignite...	11	0	481	6
	Grey marl	91	0	572	6
	Grey marl, with *Cyrena*	6	0	578	6
	Grey marl, with iron-ore and limestone...	15	8	594	2
	Grey marl, with *Cyrena*	41	3	635	5
	Pale sandy clay	89	1	724	6
Hastings Beds, 199 ft. 4 in.	Grey sand and marl, with pyrites...	46	5	770	11
	Clayey iron-ore	12	2	783	1
	Grey marl and clay, with pyrites ...	95	7	878	8
	Clayey ironstone, with cone-in-cone structure	3	8	882	4
	Grey marl, with pyrites, and tough white marl	29	8	912	0
	Not described...	11	10	923	10
Kimeridge Clay, 775 ft. 2 in.	Grey and dark grey shale	140	11	1,064	9
	Coarse oolite	1	5	1,066	2
	Shale	12	11	1,079	1
	Impure limestone, with gypsum ...	13	0	1,092	1
	Grey calcareous sandstone	49	11	1,142	0
	Shale	108	0	1,250	0
	Sandstone	94	4	1,344	4
	Shale, with thin limestone	54	6	1,398	10
	Shale, with *Ostrea bruntrutana, Exogyra sinuata* and *Pecten suprajurensis*	3	2	1,402	0
	Sandstone	80	0	1,482	0
	Shales, with fossils as above ...	81	0	1,563	0
	Shale and limestone, with *Exogyra*	136	0	1,699	0

Below the third line the figures for depths are given as 1 less than above.

The notable points in this section are (1) the great thickness of the Weald Clay, to which about another 100 feet must be added to get the total thickness, up to the Atherfield Clay. (2) The evidence of thinning of the Hastings Beds northward from their outcrop. (3) The great thickness of the Kimeridge Clay.—W.W.

Ropersole, *see* Barham.

Ruckinge (should have been entered as **Newchurch**).

LANGDON FARM, about 1¼ miles S.W. of the church, Newchurch.
1906.

Pit 9 feet, or more ?, the rest a boring of 6 inches diameter.

From copies of the record, communicated by Mr. E. LORD and Mr. C. J. GILBERT.

(Words in these brackets from "remarks" at the side of one section.)
{Notes in these brackets from specimens.}

		Thickness.	Depth.
		Ft.	Ft.
	Turf and mould	½	½
[Alluvium]	Clay, with shells (dipping sharp to east)	4	4½
	Loam sand	1½	6
	Fine grey sand {clayey}	3	9
	Sand and mud, with bands of peat. (A little water)	2	11
	Soft light-blue clay. (Grey sand) {grey sandy clay}	5½	16½
	Grey sand, with a few shells. (Water)	30	46½
	Soft light-blue clay, with bands of peat	9	55½
	Brown sand, mixed with pebbles and stones of various kinds. (Water)	10½	66
[? Weald Clay]	Grey silty clay in bands, with thin veins of sand	4	70
	Sand, with thin veins of wood, lignite or coal. (Water. Sand hard)	16	86
	Blue silty clay or gault. (A few thin veins of silty clay in the upper part of the sand) {grey sandy clay}	34	120
	Blue gault or silty clay, with a lot of lignite, the same continues, with not so much lignite. {Sandy clay, with plant remains}	7	127
	Light-blue or weald clay {grey}	5	132
	Mottled clay {pale}	2	134
	Light-blue or weald clay	7	141
	Mixed clay, with a show of lignite {pale brownish clay, with plant-remains}	3	144
	Silty clay, with a thin band of stone and some lignite {pale}	10	154
[? Hastings Beds]	Hard blue sandy clay (varying in character) {pale fine clayey sand, a lower specimen coarser and less clayey}	32	186
	Lignite and sand in veins or bands	3	189
	Hard blue sand and clay {pale clayey sand}	5½	194½
	Mixed clay and stones, with a show of shells at 206 feet	15½	210
	Hard sand with stones and clay; the greater part of the cores wash away	34	244
	Light-blue and mottled clay	3	247
	Dark hard, dry clay	3	250
	Hard silt, varying in colour, sandy in places, some lignite {pale clay at 300 and 323 feet}	71	321
	Hard dark mixed clay	9	330
	Hard blue silty clay {Brown clay at 332 feet}	19	349
	Hard and soft bands, nearly all washed away to slurry {Pale clay at 351 feet}	7	356

		Thickness.	Depth.
		Ft.	Ft.
[? Hastings Beds]	Bands of clay and sand, some lignite	42	398
	Hard sandy clay, with lignite {pyrites}	5½	403½
	Very hard stone {calcareous, with pyrites}	1	404½
	Hard silty clay, dries nearly white	13½	418
	Lignite and sand	1	419
	Sandy clay, with small pieces of rock or stone, mundic, lignite; 6 inches of hard stone {calcareous} and mundic at base	51	470
	Hard sandy clay, 6 inches of sand at base {pale clay, pale grey fine sand, and pale brownish sand} ...	4½	474½
	Clay, with sand and stone {grey} ...	8½	483
	Sandy clay or hard clay, with bands of sand	15	498
	Hard clay, mottled ?	7½	505½
	Stone and bands of clay {indistinct shells}	4½	510
	Mixed coloured clay, some very dark	8	518
	Very dark blue clay	5	523
	Mixed coloured clay, some hard ...	21	544
	Cuts hard, like stone; last 3 feet more clay. Mr. LORD notes this as hardish clay, that soon sets, of various colours	22½	566½

The last core {calcareous stone} is marked as from 575 feet. The boring was then abandoned.

From 127 to 247 feet the figures for depths are made a foot in excess of those here given; from 250 to 404½ feet, 2 feet in excess; at 418 feet, 2½ feet in excess; from 419 to 566½ feet, 2 feet in excess.

According to Mr. LORD, water overflowed at the rate of about a gallon a minute when the boring was 327 feet deep.

Swingfield, *see* Alkham.

Waldershare, *see* Coldred.

Womenswold, *see* Barham.

Wrotham. OLD SOAR, about a mile E.N.E. of Plaxtol. Begun August, 1898, ended October, 1899.

Ordn. Map 287, new ser.; Geol. Map 6.

? About 200 feet above Ordnance Datum.

From the MS. of Prof. W. B. DAWKINS by whom the site was selected and the work supervised.

There are specimens in the Museum of Owen's College, Manchester.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Atherfield Clay		?50	0	50	0
Weald Clay	Blue and grey clay, with nodules. *Paludina*, *Cyclas*, plants	433	0	483	0
	Unaccounted for	3	0	486	0
	Paludina-marble	0	9	486	9
	Blue clay with hard nodules ...	96	3	583	0
	Paludina-marble	0	3	583	3
	Blue clay	135	9	719	0
Wealden Beds	Loamy clay, with occasional layers of fine white sand, one at 724 feet, 5 feet thick...	17	0	736	0
	Blue clay	39	0	775	0
	Grey shale	15	0	790	0
	Hard sandy silt, with lignite ...	14	0	804	0
	Grey clay, with lignite	22	0	826	0
	White sand	4	0	830	0
	Grey clay	25	0	855	0
	White sand	3	0	858	0

There must now be several more works the details of which have not been published; indeed, some of those above described are wanting in various details. It is to be hoped that no mistaken idea as to keeping back information will be allowed to prevail, and that we shall soon be in possession of that knowledge which is comparatively useless if not published and submitted to criticism. Moreover, original information is apt to get lost if long withheld, and such loss is not only of scientific but also of economic import.

VARIOUS TRIAL BORINGS.

Of borings made for other purposes than finding water many accounts have been published in the two Geological Survey Memoirs that deal with such matters in Kent. But to these many others are now added.

The more notable sections are those on the line of the London County Council's new sewers at Blackheath; those on the Goodwin Sands; that of the Greenwich Ferry, showing the depth to the Chalk, as also does that at Plumstead Marsh; the deep boring at St. Margaret's; that in Stone Marshes; and those along the line of the new sewer at Woolwich.

The new borings are as follows:—

West Kent Sewerage. 1, 1a, 2a and the second set of 9.
Blackheath. (L.C.C.)
Chatham. Dockyard Extension. Eleven.
Cliffe. Twelve.
Crayford.
Darnet Fort.
Deptford. Cattle Market, three; and Market, three.
Goodwin Sands.
Greenwich. Blackwall Lane, six; Ferry,
Hoo.
Kidbrooke.
Lewisham.
Sheerness. Two sets of twelve.
Woolwich. Artillery Lane and L.C.C. new sewers.

A. METROPOLITAN BOARD OF WORKS. Trial-borings.

Bermondsey Branch Sewer.

From the Contract Drawings, 1862.

Nos. 1—6 are in Surrey.

7. Deptford Lower Road, 260 feet N.W. of Thames Junction Railway.

7 feet above Ordnance Datum. Water-level 5 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		2	2
[Alluvium, 3 feet]	Peat	2	4
	Grey clay, with shelly matter and remains of vegetable matter	1	5
Coarse, grey sand		17	22

8. Deptford Lower Road. At Black Horse Bridge, Grand Surrey Canal 8·67 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Made ground, with a foot of garden-soil beneath		5	5
[Valley Drift, 15 feet]	Clay	2	7
	Sandy loam	2	9
	Gravel and sand	3	12
	Hard sand	¾	12¾
	Boggy clay	½	13¼
	Sand and gravel	6¾	20

9. Deptford. Evelyn Street, 350 feet S.E. from Black Horse Bridge. 11·78 feet above Ordnance Datum. Water-level 6 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[Soil, etc.]	Made ground, with 6 inches of road-metal	3	3½
	Mould	1½	5
[Valley Drift, 19½ feet]	Sand and gravel	3	8
	Gravel	16½	24½
[Thanet Sand, 7 feet]	Sand	1½	26
	Dark blue sand	5½	31½
Chalk		18	49½

10. Deptford. Evelyn Street, High Street. 18·64 feet above Ordnance Datum. Water-level 12 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground, with 6 inches of ballast at top ...		5½	5½
[Valley Drift, 36½ feet?]	Gravel	16½	22
	Sand	4	26
	Sand and gravel	2	28
	Gravel	14	42

11. Deptford. High Street, Griffin Street. 22 feet above Ordnance Datum. Water-level 14 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[Soil, etc.]	Made ground	3½	3½
	Mould	4	7½
[Valley Drift]	Coarse gravel...	10	17½
	Ferruginous and ochreous gravel	8	25½
Light-yellow sand		17	43

12. Deptford. Flood Street (W. of Creek Street) at back of houses on eastern side of street and a little S. of Greenwich Railway. 11·07 feet above Ordnance Datum. Water-level 6 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Mould ...	... ...	5	5
[Valley Drift, 28 feet]	Loam and clay	4	9
	Sand and gravel	18	27
	Sand	2	29
	Gravel	4	33
Silty sand	... ...	14	47

13. Deptford Creek, Gasworks on east. 15·93 feet above Ordnance Datum. Water-level 10 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Mould		12	12
[? Alluvium] Peaty clay		1	13
[Valley Drift, 20½ feet]	Sand and gravel	15	28
	Light-grey and grey sand	2	30
	Light-grey sand and gravel	3½	33½

14. Deptford Creek. In Mr. Williams' Tanyard. [? Greenwich Road, near North Pole Lane.] 8·68 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Mould		1	6	1	6
[Alluvium, 7¾ feet]	Clay	1	7	3	1
	Peat	6	3	9	4
[Valley Drift, 17¾ feet]	Flint gravel	6	8	16	0
	Sand and gravel	4	0	20	0
	Gravel	7	0	27	0
Sand [of Lower London Tertiaries] (5 beds, according to Messrs. Docwra)		26	8	53	8

Outfall Sewer. South Side. From the Contract Drawings.

1. Same as No. 14 Low Level Sewer, Bermondsey Branch (next above).

2. Greenwich. Junction of Romney Road and King Street.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		5	5
[Valley Drift, 20½ feet]	Sandy loam	5½	10½
	Red gravel	5½	16
	Yellow sand	1½	17½
	Gravel, the lower half sandy	8	25½

3. Greenwich and Woolwich Lower Road, opposite Vicarage Lane and West Combe Cottage.

		Thickness.	Depth.
		Ft.	Ft.
Made ground ...		1	1
[Valley Drift, 23 feet]	Clayey gravel ...	2	3
	Loamy gravel ...	4	7
	Quick sand	9	16
	Clay and sand ...	1	17
	Gravel (much water)	5	22
	Flints	½	22½
	Sand and chalk ...	1½	24
Chalk, soft for 6 feet, then hard ...		9	33

4. Greenwich and Woolwich Lower Road, Coombe Farm Lane, E. of Victoria Road.

		Thickness.	Depth.
		Ft.	Ft.
Made ground ...		6	6
[Valley Drift, 24½ feet]	Dark yellow sand and a little gravel	8	14
	Light-yellow sand and gravel ...	7	21
	Chalk and light-coloured flint rubble	2	23
	Sand and gravel	7½	30½
Chalk ...		5½	36

5. Greenwich and Woolwich Lower Road, Charlton Lane.

5 feet of made ground over Chalk, the top 4 feet loose.

6. Woolwich. Albion Road, Sand Street.

	Thickness.	Depth.
	Ft.	Ft.
Road-metal	½	½
Peaty earth, chalk and flint fragments	16½	17
Chalk, the top 10 feet loose	23	40

7. Woolwich. Albion Road, Harden Street.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		2	2
[Thanet Sand, 13 feet]	Brownish sand	5	7
	Grey sand ...	7	14
	Flints ...	1	15
Loose chalk and flints ...		34	49

8. Northern side of South Eastern Railway, near eastern end of Tunnel E. of Charles Street.

		Thickness.	Depth.
		Ft.	Ft.
Mould		2	2
[Thanet Sand, 50½ feet]	Brownish sand ...	4	6
	Light-yellow sand	24	30
	Dull yellow sand	13½	43½
	Grey sand ...	9	52½
Chalk		7	59½

9. Woolwich. Beresford Square, Beresford Street.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground, &c.		3	4	3	4
[Thanet Sand, 47 feet]	Light-yellow sand	43	2	46	6
	Dull yellow sand	4	0	50	6
Chalk		9	6	60	0

10. Plumstead Road, about half-way between Ann Street and the Railway Station.

		Thickness.	Depth.
		Ft.	Ft.
Road-gravel		1	1
[Thanet Sand, 48 feet]	Bright brown sand ...	4	5
	Light-brown sand ...	11	16
	Light-yellow sand ...	9	25
	Dull yellow sand ...	5	30
	Light-coloured sand ...	6	36
	Dark grey sand ...	13	49
Chalk		6½	55½

11. Church Manor Way Plumstead Marsh.

		Thickness.	Depth.
		Ft.	Ft.
Mould		2½	2½
[Alluvium, 11½ feet]	Brown clay	1½	4
	Silty clay	1	5
	Peat	5½	10½
	Dark, and then light silty, sand ...	3½	14
[Valley Drift, 28½ ft.]	Sand and gravel	3	17
	Dull yellow, subangular flint gravel	25½	42½
Dark grey [? Thanet] sand		2	44½

12. In Plumstead Cross Manor Way.

		Thickness.	Depth.
		Ft.	Ft.
Road-gravel		1	1
[Alluvium, 17½ feet]	Dark brown clay	6	7
	Brown clay, with traces of vegetable matter	3	10
	Peat	8½	18½
Grey, subangular flint gravel		13	31½

13. In Cross Manor Way, Plumstead Marsh.

		Thickness.	Depth.
		Ft.	Ft.
Surface soil		1½	1½
[Alluvium, 16½ feet]	Light-brown clay	5	6½
	Brown, silty clay, with vegetable matter	2	8½
	Peat	5½	14
	Dark grey, silty clay	1½	15½
	Peat	1	16½
	Dark grey, silty clay	1½	18
Grey, subangular flint gravel		27½	45½
[Thanet Sand ?]	Grey sand	1½	47
	Dark grey sand	2	49
	Black sand	1	50
	Grey sand	3	53

Southern Outfall Works. From the Contract Drawings.

[Erith, Crossness.]

In and near Reservoir; at the outfall by the river-side.

1. In the Engine House. 4·6 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil		1	2	1	2
[Alluvium, over 22 feet]	Brown clay	3	4	4	6
	Blue clay	5	9	10	3
	Peat	0	6	10	9
	Fine sand	1	6	12	3
	Peat	1	9	14	0
	Peat and blue, silty clay	1	6	15	6
	Blue, silty clay	3	9	19	3
	Blue, silty clay, with layers of peat	2	6	21	9
	Peat	1	7	23	4
[Valley Gravel]	Shingly gravel	4	11	28	3
	[Gravel ?]	4	0	32	3

2. East of the Engine House.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil ...	... ...	1	3	1	3
[Alluvium, 17¾ feet]	Brown clay	3	3	4	6
	Peat	3	0	7	6
	Blue, silty clay ...	4	6	12	0
	Peat and clay in layers	1	6	13	6
	Blue, silty clay ...	3	6	17	0
	Silty sand	2	0	19	0
[Valley Gravel]	Fine, sandy gravel ...	1	3	20	3
	Thames ballast ...	2	9	23	0

4. Near the south-western corner of the Reservoir.

	Thickness.		Depth.	
	Ft.	in.	Ft.	in.
Soil	1	3	1	3
Blue, silty clay [Alluvium]	18	3	19	6
Fine, sandy ballast ...	4	6	24	0
[? The same]...	5	0	29	0

MSS. Borings.

Nos. 1 and 2 are in Surrey.

3, Creek Bridge Road, Deptford, near the Bridge. 12 ft. 5 in. above Ordnance Datum.

	Thickness.	Depth.
	Ft.	Ft.
Made ground	6	6
Bog clay [Alluvium]	14	20
River gravel deposit, with remains of wood piles	6	26
Mottled clay, like Fuller's earth	2½	28½
Clay, with green sand	4½	33

15. Greenwich Marshes (? Blackwall Lane, eastward of St. Andrew's Church). 5 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Alluvium]	Mould	1	0	1	0
	Clay	3	6	4	6
	Peat (after passing through which water rose)	2	8	7	2
[Valley Drift]	Sand, with water	5	10	13	0
	Chalk, silt and sand	2	0	15	0
	Gravel	16	6	31	6
Running sand ...	... ...	18	6	50	0

16. Plumstead Marshes (? near the Thames opposite Barking Creek). 4½ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay	6	6
	Peat (after passing through which water rose)	19	25
	Clay and silt	1	26
[River] Gravel		14	40
Chalk		20	60

18. Greenwich Marshes (? close to the Thames, about a third of a mile S.E of Blackwall Point). 6·12 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 20 feet]	Mould	1	1
	Yellow clay	3½	4½
	Blue, muddy clay	8	12½
	Peat	2½	15
	Silty clay (after passing through which water rose)	1	16
	Silt	3	19
Sandy gravel		20	39
Blue clay...		12	51

B. West Kent Sewerage.

Made and communicated by Messrs. Docwra, and partly from Mr. G. Chatterton.

1. Foxgrove Farm, Beckenham.

		Thickness.	Depth.
		Ft.	Ft.
[Blackheath Beds]	Sand	6	6
	Ballast [pebbles]	6	12
	Sand and clay...	2	14
	Ballast [pebbles]	10	24
[? Blackheath or Woolwich Beds]	Mottled clay	1½	25½
	Bluish clay	1½	27
	Blue ballast [pebbles] and sand ...	3	30
	Green ballast [pebbles]	10	40
[Woolwich Beds. ? Thanet Sand]	Green sand	2	42
	Black sand	2½	44½
	Hard grey sand	5½	50
	White sand	15	65

1A. Beckenham and South Catford [? South End] Road, by Lodge to Park.

		Thickness.	Depth.
		Ft.	Ft.
Soil		¼	¼
Sand and small [fine] gravel		2¾	3
Sandy [London ?] clay		4	7
[Blackheath Beds]	Large [coarse] ballast [pebbles ?]	10	17
	Ballast [pebbles ?] and clay	3	20
	Live sand	8	28
	White sand and pebbles	½	28½

2. Durham Hill Lane, about a third of a mile north-eastward of Holloway Farm, Bromley.

152 feet above Ordnance Datum.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Mould		0	6	0	6
[London Clay]	Loam	3	6	4	0
	Brown clay	3	0	7	0
	Brown clay, with veins of red sand and large clay-stones	13	0	20	0
	Blue clay	26	0	46	0
	Dark sand	3	0	49	0
	Blue clay, with veins of sand	5	0	54	0
	Blue clay	7	0	61	0
	Dark clay, with sand	7	0	68	0
	Black gravel [flint-pebbles] and clay [? Basement-bed]	2	0	70	0
[? Blackheath Beds]	Brown sand	1	6	71	6
	Brown rock-sand	15	2	86	8
[Woolwich Beds]	Black clay and shells	2	0	88	8
	Sand	2	0	90	8
	Black clay and shells	6	7	97	3

2A. Southern End of Catford.

		Thickness.	Depth.
		Ft.	Ft.
[? Drift]	Loam	1	1
	Clay and ballast	2	3
	Gravel	4	7
	Blue clay	1	8
	Sand and loam	3	11
	Gravel	3	14
[Woolwich and Reading Beds]	Shelly clay	1	15
	Blue clay	7	22
	Shelly clay	2	24
	Shells, sand, and clay	2	26
	Shelly clay	2	28
	Coloured [mottled] clay	3	31
	Grey sand and clay	4	35

2B. By Ditch, about half a mile west of Claypit Farm, south-west of Mottingham, and south of east from Shrofield Farm, Lee.

144¾ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Sandy loam	2	2
	Yellow clay	5	7
	Yellow sand and clay	7	14
	Black sand and clay	10	24
	Blue clay (with clay-stones; 2 feet at 27 feet down, 3 feet at 53 feet down, 4 feet at 59 feet down)	67	91

2C. Mottingham, corner of field about a third of a mile south-west of Fairy Hall.

110¼ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[Gravel]	Yellow loam and ballast	4	4
	Black [London] clay	4	8
[Blackheath Beds, 10 feet]	Black pebbles	4	12
	Live white sand	6	18
[Woolwich and Reading Beds, 39 feet]	Sandy clay	2	20
	Black clay, with beds of shells	12	32
	Oyster-shells	4	36
	Congealed [cemented] sand and shells	5	41
	Black clay, with veins of shells	9	50
	Mottled clay	7	57

3. Just south of Railway north of Chapel Farm, a little eastward of Eltham Station.

? 136¼ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
	Peat	5½	5½
[? Trace of London Clay]	Clay, with pebbles	5½	11
[Blackheath Beds, 5½ feet]	Pebbles and shells	2½	13½
	Rock and shells	1½	15
	Dead sand	1½	16½
[Woolwich and Reading Beds, 34½ feet]	Clay and shells	7	23½
	Shells	2	25½
	Clay	4½	30
	Shells and shingle	4	34
	Clay and shells	6	40
	Hard, white, loamy clay	5	45
	Hard, yellow clay	2	47
	Shingle	1	48
	Ballast	3	51
[Thanet Sand, 35¼ feet]	Green sand	19½	70½
	Hard, brown sand	4	74½
	Hard, brown sand, with black pebbles [? carried down]	11¾	86¼

3A. Pope Street (New Eltham of the new map), south-eastern side of road, at footpath to Valliers Wood (and just north-east of Eltham Boring 5, see p. 260).

128¾ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay]	Yellow clay...	12	12
	Black clay	10	22
[Blackheath Beds]	Black pebbles	12	34
[Woolwich and Reading Beds, 51 feet]	Black, shelly clay	12	46
	Cockle shells [*Cyrena* ?]	4	50
	Black clay and shells	10	60
	Mottled clay	2	62
	Hard, green sand	18	80
	Hard, black sand	5	85

4. Just west of Abbeyhill, about half a mile east of Lamorbey Church.

96½ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[? Oldhaven or Blackheath Beds, with surface-earth ?]	Loam and sand	3	3
	Gravel	2	5
	Red sand	4	9
	Lighter-coloured sand	1	10
[Woolwich and Reading Beds, ? 38 feet]	Dark sand and clay	3	13
	Shell sand ... ... Dark clay and shells ...	17	30
	Black clay	1	31
	Hard, coloured [mottled] clay ...	3	34
	Clay and shingle	8	42
	Hard, green rock-sand	5	47
	Black sand	1	48
[Thanet Sand]	Light-brown sand	19	67
	Live sand	3¼	70¼

Another set of shallower borings, for the West Kent Sewer, have also been communicated by Messrs. Doowra :—

1. Kent House Farm, Beckenham [? east of].

[? Blackheath Beds]	Loamy sand	2	9 feet
	Shingle and ballast ...	2	
	Red sand	3	
	White sand and water	2	

2. Hurst Farm, Sidcup.

Soil ...	... ...	1	7 feet
[? Blackheath Beds]	Loam and sand ...	1	
	Loam and pebbles ...	1½	
	Black sand	1	
	Clay and pebbles ...	2½	

3. By Footpath below the Hurst, Sidcup.

		Thickness.	Depth.
		Ft.	Ft.
Soil	... ...	1	1
[? Blackheath Beds]	Loamy clay	1	2
	Red gravel	1	3
	Black gravel	7	10
	Loamy clay	2	12
	Sand	6	18
	Black pebbles... ...	½	18½
	Red sand and pebbles	1	19½
	Green sand	1	20½

4. By Weir below Moat Misery, Sidcup.

Soil	3	7 feet
Pebbles ...	1	
Black pebbles	1	
Silty sand ...	1	
Black pebbles	1	

5. In Meadow by Bourne House, Bexley.

Soil	... ...	1½	6½ feet
[? Drift]	Loamy clay ...	2	
	Silty sand ...	½	
	Black pebbles	½	
	Black sand ...	½	
	Black pebbles	1½	

6. Hallcote Farm.

Soil ...	3	7 feet
White sand	1	
Red sand...	3	

7 and 8. Marsh Street Farm, Dartford. 9. Riverside, St. Mary's Cray.

		(7)	(8)	(9)	
Soil	... ...	2	2	2	all 11 feet
[Alluvium]	Blue clay	2	1½	4	
	Peat ...	7	7½	5	

C. MISCELLANEOUS BORINGS.

These are arranged alphabetically, by places, as in the case of Wells.

Blackheath. LONDON COUNTY COUNCIL'S NEW SEWER.

Five shafts. From close to the pond by the "Hare and Billet" (north-west of Railway Station), south-eastern corner of the Heath, close to Charlton Road.

T. V. Holmes, *Geol. Mag.*, 1907, dec. v., vol. iv., pp. 213-215.
No. 1, near the "Hare and Billet."
No. 5, about 70 yards southward of the south-eastern corner of Greenwich Park.

The following water-levels were supplied by Mr. B. C. Cass: —

Shaft 1.—140 feet above Ordnance Datum.	Water found 24½ feet down.
Shaft 2.—150 feet above Ordnance Datum.	Water found 32 feet down.
Shaft 3.—150 feet above Ordnance Datum.	No water.
Shaft 4.—146 feet above Ordnance Datum.	Water found 32 feet down.
Shaft 5.—147 feet above Ordnance Datum.	Water found 32 feet down.

The water, which, percolating through the Blackheath Beds, is upheld by the more or less clayey Woolwich Beds, nowhere formed any serious obstacle to making the shafts. No. 3 was sunk some months later than Nos. 1 and 4.

SHAFT 2. On the Heath, close to Talbot Place, Blackheath Vale.

		Thickness.	Depth.
		Ft.	Ft.
Soil ...	... ...	1	1
Blackheath Beds, 38 feet	Loamy gravel	24	25
	Yellow loamy sand ...	9½	34½
	White sand	4½	39
Woolwich Beds, 14 feet	Shell-deposit	1¾	40¾
	Blue clay...	3¾	44½
	Pebbly sand	2	46½
	Blue clay...	½	47
	Loamy sand and pebbles	6	53
Thanet Sand, 49½ feet	White sand	48½	101½
	Black sand and flints ...	1	102½
Chalk	... ...	20¾	123¼

SHAFT 3. Close to, and on the northern side of, the road across the Heath, about 180 yards north-eastward of Talbot Place.

		Thickness.	Depth.
		Ft.	Ft.
Soil ...	... ...	1	1
Blackheath Beds, 37 feet	Loamy gravel	9	10
	White sand	23	33
	Loamy sand	5	38
Woolwich Beds, 15¾ feet	Shell-deposit	1	39
	Loamy sand	¾	39¾
	Shell-deposit	1¾	41½
	Yellow clay	3¾	45¼
	Hard mixture of clay, sand, and pebbles	7¾	53
	Green sand	¾	53¾
Thanet Sand, 49¾ feet	White sand	48¾	102½
	Black sand and flints...	1	103½
Chalk ...	... ...	19¾	125¼

SHAFT 4. Close to the southern side of Shooter's Hill Road, about 416 yards north-eastward of Talbot Place.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Soil	...	0	6	0	6
Blackheath Beds, about 38 feet	Dirty ballast [gravel]	9	6	10	0
	Yellow clay	1	6	11	6
	Ballast ...	4	6	16	0
	Loamy sand	8	0	24	0
	White sand	1	3	25	3
	Loamy sand	5	8	30	11
	White sand	7	6	38	5
Woolwich Beds, 14 feet	Red sand	2	3	40	8
	White sand	4	9	45	5
	Hard mixture of clay, sand, and pebbles	4	0	49	5
	Green sand	3	0	52	5
Thanet Sand	White sand	48	1	100	6
	Black sand and flints...	1	0	101	6
Chalk	...	18	3	119	9

There seems to be some doubt as to the division between the Blackheath and the Woolwich Beds in this last. The red and white sands might belong to the former rather than to the latter. Mr. HOLMES suggests that the irregularity (in the absence of the Woolwich shell-beds) may have been brought about by subsidence, of which there are evidences near by. This irregularity is made the greater by the suggestion above as to classification, which would leave only 7 feet of Woolwich Beds; but this may be explainable by ordinary natural causes, as the Blackheath Beds rest erosively on the beds below.

Charlton.

1. MARSH at Angerstein's Sluice. 1839.

7 feet below T.H.W.M.

Communicated by Mr. J. B. REDMAN.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Strong clay	4	4
	Peat ...	3	7
	Silt ...	$\frac{2}{3}$	$7\frac{2}{3}$
	Peat ...	$3\frac{1}{3}$	11
[River Drift]	Sand ...	$1\frac{2}{3}$	$12\frac{2}{3}$
	Gravel ...	$1\frac{1}{3}$	14

2. Messrs. SIEMENS & Co.'s WORKS, on the marsh just W. of Woolwich Dockyard.

Communicated by Messrs. SIEMENS.

(1 and 2 are wells, see p. 98. The following, 3 to 14, are trial-borings.)

3. BORING, afterwards excavated down to gravel. About 100 yards from the western end of the works and 45 N. of Bowater Road (? on the southern side of Harrington Road, if it goes so far W.).

12½ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[? Made Ground]	Excavated	4	4
	Clay-filling	8½	12½
[Alluvium, 22 feet]	Mould	4½	17
	Clay	4½	21½
	Peat	3½	25
	Silty clay	8	33
	Silty clay and gravel	1½	34½
[River] Gravel		10½	45
Soft chalk		5½	50½

4 and 5. Borings in front of the Wharf, about 680 and 630 feet W. of Woolwich Dockyard.

Level of beach 8 feet below Ordnance Datum.

Showed 10 and 11 feet of Alluvium (mud, peat, and silt) over River Drift (sand and gravel), to 8 feet, or more.

		6.	7.
		Ft.	Ft.
Excavated. Various materials, mostly filled in, to clay		12½	11½
[Alluvium]	Clay	4	3½
	Peaty clay	3	3
	Peat	7	6
	Silty clay	3	3
Gravel		1	½
		30½	27½

8. About 45 feet N. of Bowater Road and 140 feet W. of Trinity Street.

9 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Excavated. Various materials, mostly filled in, to clay		9	9
[Alluvium]	Clay	3½	12½
	Peaty clay	3½	16
	Peat	8½	24½
[River] Gravel		6½	31

9. About 10 yards N. of Bowater Road and 40 W. of Trinity Street.

9 feet above Ordnance Datum.
To Gravel (no details) 26½ feet.

10 and 11. Excavated. 11 feet above Ordnance Datum.

12 to 14. Abyssinian Tube Wells, afterwards excavated down to gravel.

Respectively 12, 11½, and 12½ feet above Ordnance Datum.

10 about 50 feet N. of Bowater Road and 110 W. of Trinity Street.

13, 11, 12 and 14 along a line S. and N. between Bowater Road and Harrington Road from about 80 to 70 feet W. of Trinity Street.

—		10.	11.	12.	13.	14.
Various materials, for the most part filled in, and mould		14½	14½	15	14½	15½
[Alluvium]	Clay	4½	4	4½	3¼	3¼
	Peaty clay ...	5½	5½	5½	6¾	6¾
	Peat	3	3	3	3	3
	Silty clay ...	touched.	touched.	1	9½	38½ ?
Gravel		—	—	—	—	1 ?
Soft chalk						
		27½	27	29	37	68

Chatham. Dockyard Extension.

Notes of Borings, &c., made by C. E. Hawkins in 1871.

The beds varied so much, even in short distances, that it is impossible to give any one section as fairly representative.

St. Mary's Island is "the gift of the Medway," and St. Mary's Creek is an old channel of the river, or rather was so before it was stopped up and then excavated for the new basins.

A selection from the borings is given.

Trial-pit (the rest are borings) in St. Mary's Creek, close to low-water mark and 10 feet below the level of high-water of spring-tides.

The present channel of the Medway is distant on the west about ¼ mile and on the east about ½ mile and on the north rather less than ½ mile from the site.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 34 feet]	Mud and silt	16	16
	Hard silt	14	30
	Mixture of silt, gravel, sand and peat	3	33
	Hard loamy sand	¾	33¾
	Peat	¼	34
[River Drift]	Hard gravel (a natural concrete)	1	35
	Loose gravel	5½	40½
[? Thanet Beds]	Large flints, with loam, to Chalk	½	41

About 60 yards N.E. of the Trial-pit, the surface just above high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay and peat... ...	10¼	10¼
	Stiff clay	10	20¼
	Clay and peat... ...	5	25¼
	Silt and peat	5	30¼
	Silt	5	35¼
	Clay and silt, to gravel	7	42¼

About 60 yards S. of the Trial-pit, on the southern side of the Creek, 15 feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Mud	1½	1½
	Mud and peat... ...	3½	5
	Peat and silt	5	10
	Mud and silt	5	15
	Silt	5	20
	Silt and clay, to gravel	8	28

80 yards S.W. of the last, the surface 3 feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Peat with clay	5	5
	Clay with peat	5	10
	Mud and clay	5	15
	Soft clay ...	10	25
	Silt and clay	10	35
	Silt, to gravel	10	45

70 yards S.W. of the last, the surface 3 feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay with peat	10	10
	Peat (with clay)	5	15
	Soft clay	5	20
	Clay	5	25
	Clay (with silt)	10	35
	Silt (with clay), to gravel	11	46

270 yards S.E. of the Trial-pit and on the northern side of the Creek, the surface at level of high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Mud and clay ...	5	5
	Peat (with clay)	5	10
	Clay (with peat)	5	15
	Peat with clay	5	20
	Silt	5	25
	Peat (with clay)	5	30
	Peat	5	35
	Silt and peat ...	5	40
	Silt, to gravel...	6½	46½

270 yards southward of the above, on the southern side of the Creek. Surface 13 feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 22 feet]	Mud	2	2
	Peat	8	10
	Clay (with peat)...	5	15
	Peat (with clay) ...	7	22
	[River] Gravel, to hard [? Thanet] sand	7	29

260 yards N.E. of the above. At the level of high-water spring-tides. About 150 yards away from the Creek (in St. Mary's Island).

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Clay and peat	10	10
	Clay	5	15
	Clay and peat	5	20
	Silt	5	25
	Clay and silt	10	35
	Stiff clay (with sign of peat) to gravel	7	42

At the western entrance to St. Mary's Creek, the surface 18 feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Mud	5	5
	Silt	10	15
	Silt and mud ...	5	20
	Silt	5	25
	Hard sand, to gravel	4	29

At the eastern entrance to St. Mary's Creek, surface 13½ feet below high-water spring-tides.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 32 feet]	Soft mud	25	25
	Hard mud and clay	5	30
	Clay and gravel ...	2	32
[River Gravel]	Sandy gravel ...	9	41
	Gravel	8	49
Loam [? Thanet Beds] to Chalk...		5	54

About 260 yards N.W. of the Trial-pit and 100 yards or so north of the Creek (in St. Mary's Island), surface 6 inches above high-water spring-tides.

[Alluvium]	Clay and peat	20½	41½ feet.
	Silt, with clay	15	
	Clay (with silt), to gravel	6	

Cliffe. Messrs. Francis & Co.

Twelve borings, made and communicated by Messrs. Isler & Co.

Thicknesses in feet.

	1	2	3	4	5	6	7	8	9	10	11	12
Soil ...	2	1½	3	3	4	3	2½	1½	2	1¼	5	1¼
Bullhead [? flints]	3	4½	5	4½	3	2½	3½	4½	4	1	1½	1¾
Chalk ...	4	2	1	? touched			½	? touched	½	½	? touched	½
Total	9	8	9	7½	7	5½	6½	6	6½	2¾	6½	3½

Crayford. Kent Waterworks. Trial-hole.

Made and communicated by Messrs. Isler & Co.

[River Drift]	Sandy Clay ...	6	38 feet
	Ballast [gravel	13	
Chalk		19	

Darent (in the valley of that river).

Communicated by Mr. T. Hennell.

Darenth, a quarter of a mile W. of Blackdale Farm. Black bog and gravel, 9 feet.

Dartford, near the edge of the marsh below the Powder Mills, and a little over two-thirds of a mile S.S.E. of the Railway Station. Sandy clay, 12 feet.

Dartford, near the edge of the marsh, about an eighth of a mile a little N. of W. from Hill House (some error as to site). Sandy clay, 10 feet, and gravel, a foot.

Dartford, nearly a quarter of a mile S.E. of the Railway Station. Sandy clay, 10 feet, and gravel, 2 feet. No brickearth shown on the map.

Darnett Fort.

Borings made for and communicated by the WAR OFFICE.

		Feet.
[Alluvium]	Clay ... ... over	½
	Hardclay	4
	Clay and peat... ...	2
	Clay	8
	Clay and a little peat	4
	Peat	2
	Clay	2
	Sand and clay... ...	2
	Sand with less clay ...	4
	To fine sand, about	28½

Another section was as follows :—

		Ft.	in.
[Alluvium]	Brown clay	2	0
	Blue clay	2	0
	Peat	0	2
	Blue clay	4	8
	Peat	0	2
	Blue clay	10	8
	Clay with a little sand	3	0
	Clay with more sand, the latter increasing with the depth	5	0
		27	8

Deptford.

1. BURT'S WHARF, near Earl Outlet.

From a MS. Book of Borings in the Engineer's Office, Metropolitan Board of Works (No. 1).
9¾ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Made ground	... ...	8	8
[Alluvium]	Blue clay ...	4	12
	Peat	5	17
[River Drift]	Running sand	5	22
	Gravel ...	5	27

2. CATTLE MARKET.

Trial-holes made and communicated (1905) by Messrs. A. WILLIAMS & Co.
No. 1 with 3 feet of water in bore-hole.

	Thickness.	Depth.
	Ft.	Ft.
Made ground and clay	7	7
Sand and gravel ...	5	12
River mud and stones	4	16
River ballast	1	17
Drab clay	3	20

No. 2.

Made ground ...	7	20 feet.
Dry hard gravel	13	

No. 3, with 2 feet of water in bore-hole.

Made ground	17	20½ feet [? all made ground]
Hard bricks	2	
Ballast ...	1	
Timber ...	½	

3. Market.

[? Another set at same place as above.]
Six feet of water in all three.

No. 1.

[Made ground, 6 feet]	Concrete ...	½	15 feet.
	Made ground ...	4	
	Old concrete ...	1½	
[Alluvium, 9 feet]	Hard yellow clay	2	
	Black clay ...	1½	
	Mottled clay ...	3½	
	Black peat ...	2	

No. 2.

Made ground ...	... ...	5	17½ feet.
[Alluvium, 12½ feet]	Yellow clay ...	6½	
	Blue clay ...	1	
	Black fine peat	2½	
	Soft yellow clay	2½	

No. 3.

Made ground ...	... ...	5½	15 feet.
[Alluvium, 9½ feet]	Yellow clay... ...	4½	
	Light-blue clay ...	4	
	Black peat	1	

Eltham. Sewerage.

Communicated by Messrs. Law and Chatterton.

1. Junction of Mottingham Lane and Eltham Road.

72·33 feet above Ordnance Datum.

[Valley Drift, 6 feet]	Brown, sandy loam ...	3	15½ feet
	Sand and gravel	3	
[London Clay, 9½ feet]	Blue clay and sand ...	5½	
	Blue clay and more sand	4	

2. Mottingham Lane. Just N. of the brook where it joins the lane (S. of Railway).

96 feet above Ordnance Datum.

	Thickness.	Depth.
	Ft.	Ft.
Yellow, sandy loam ...	5	5
Sand and gravel	1	6
Sand, gravel and clay ...	3	9
Blue clay and sand... ...	5	14
Blue clay and less sand ...	9	23
Blue clay	4	27
Blue clay and broken shells	3	30

It is hard to classify the beds. The top three may be Drift, or London Clay and Blackheath Beds. The bottom one belongs, of course, to the Woolwich Beds, and so may the three next above, as one would not expect to find London Clay resting on Woolwich Beds.

3. Railway (northern side) by stream, just E. of Eltham Station.

129·45 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[Woolwich Beds, 33 feet]	Loam	2	2
	Yellow clay	3	5
	Clay and broken shells	4	9
	Clay, sand and shells	3	12
	Mixed clay	3	15
	Blue clay	4	19
	Clay and gravel	5	24
	Clay and sand (mixed)	9	33
Yellow [Thanet] sand		21	54

4. E. of Green Lane, opposite S.E. corner of Park (about ¼ mile S. of South End).

147·26 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
[London Clay, 32 feet]	Brown clay	15	15
	Blue clay	17	32
[Blackheath Beds, 2½ feet]	Gravel	1	33
	Sand and gravel	1½	34½
[Woolwich Beds, 28½ feet]	Blue clay	11½	46
	Blue clay, gravel, and shells (very hard)	15	61
	Blue clay and broken shells	2	63

The thinness of the Blackheath Beds is remarkable.

5. Pope Street (New Eltham of the new map), about ¼ mile N.E. of Lower Belmont, (and just S.W. of West Kent Sewer boring 3a, see p. 249).

130·37 feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Gravel, mixed with clay		2	2
[London Clay 21 feet]	Brown clay	9	11
	Blue clay	12	23
[Blackheath Beds, 15 feet]	Gravel	14	37
	Sand, with water	1	38
[Woolwich Beds]	Blue clay, sand, and broken shells	6	44

Goodwin Sands.

1. About 1850. Cylinder.

Sir J. N. Douglass, *Proc. Inst. Civ. Eng.*, vol. ci., p. 48.

	Thickness.	Depth.
	Ft.	Ft.
Clean, sharp coarse sand	20	20
Ditto, slightly tinged with sedimentary [? organic] matter	20	40
Perforated chalk [stones], lumps of *Pholas* cells [? shells], wormed stones, mud, broken shells, fine shingle, and dark silt and sand	10	50
Clean sand	5	55
Clean bright sand, with broken shells	5	60
Sand, deeply tinged with sedimentary [? organic] matter, with gravel, small fragments of decayed timber, and pieces of coal	5	65
Sand, very black and fetid, with lumps of clay ...	5	70
Shells, small chalk nodules, and pebbles; to solid chalk, with a slight covering of mud	5	75

The following, for which I have to thank Mr. T. V. Holmes, is perhaps only a different account of this boring; but in neither case is the exact site given.

2. Made, by order of the Trinity Board, Oct., 1849. "An iron cylinder, 2 ft. 6 in. in diameter was sunk 10 lengths by Dr. Potts' ingenious plan of atmospheric pressure." (G. B. Gatty, Memorials of the Goodwin Sands, *Lond.* 1890. Details below from p. 5).

	Thickness.	Depth.
	Ft.	Ft.
Clear bright sand	10	10
„ „ „ bluish cast	14	24
„ „ „ deeper blue, sulphuretted smell	6	30
„ „ „ colour of blue clay	16	46
Small stones, broken shells, chalk nodules	5	51
Clear broken shells	11	62
Decayed wood, sea-coal, broken shells, small stones	5	67
Dark fetid sand	1	68
Shells, black nodules of clay	2	70
Clean bright sand, pebbles, chalk, milky-coloured water	2	72
Pure chalk only	6	78

Grain, Isle of.

1. Fort.

Three borings, made for and communicated by the War Office, show from 2 to 6 feet of surface-soil, over from 6½ to 12 feet of gravel and sand, over London Clay.

2. AUXILIARY BATTERY.

Two borings made for and communicated by the War Office.

Outside the river-wall.

Soft, muddy clay, very wet and loose towards the bottom, 40 feet.

Inside the river-wall.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Soft clay	11	11
	Black sand ...	3	14
	Soft clay	8	22
	Rather harder clay	4	26
	Shingle	1	27
	Soft, muddy clay...	13	40

Gravesend.

RECREATION GROUND, New Tavern Front.

Communicated by Mr. J. H. GREATHEAD.

		Thickness.	Depth.
		Ft.	Ft.
Soil		1	1
[Alluvium, 14¼ feet]	Clay ...	7¾	8¾
	Yellow clay	6½	15¼
Gravel and sand		3½	18¾
Chalk		22¼	41

Greenwich.

1. BLACKWALL LANE. For Messrs. REDPATH BROWN.

Six trial-borings of 4 inches diameter, made and communicated by Messrs. ISLER & Co.

No. 1.

Made ground	4	44 feet
[Alluvium] Peat and clay	23	
[River Gravel] Ballast...	17	

No. 2.		Thickness.	Depth.
		Ft.	Ft.
Made ground		9	9
[Alluvium 13 feet]	Silt	6	15
	Clay	3	18
	Peat	2	20
	Blue clay ...	2	22
River Drift, 21 feet]	Ballast [gravel]	9	31
	Running sand	5	36
	Shingle ...	3	39
	Ballast [gravel]	4	43

No. 3.		Thickness.	Depth.
		Ft.	Ft.
Made ground		6	6
[Alluvium, 22 feet]	Silt	12	18
	Clay	3	21
	Peat	3	24
	Blue clay	4	28
[River Drift, 13 feet]	Ballast [gravel]	2	30
	Running sand	7	37
	Ballast	4	41

No. 4.		Thickness.	Depth.
		Ft.	Ft.
Made ground		7	7
[Alluvium, 14 feet]	Silt	7	14
	Clay	5	19
	Peat	2	21
[River Drift, 26 feet]	Loamy sand	4	25
	Ballast [gravel]	4	29
	Running sand	6	35
	Ballast	12	47

No. 5.		Thickness.	Depth.
		Ft.	Ft.
Made ground		5	5
[Alluvium]	Silt	6	11
[River Drift, 24 feet]	Ballast [gravel]	2	13
	Blowing sand	1	14
	Ballast	21	35

No. 6.		Thickness.	Depth.
		Ft.	Ft.
Made ground		5	5
[Alluvium, 16 feet]	Silt	8	13
	Clay	6	19
	Peat	2	21
[River Drift]	Loamy sand	5	26
	Ballast [gravel]	10	36

2. Greenwich Ferry Co., opposite Horseferry Road. 1888?

Communicated by Mr. G. J. Cross, Managing Director.
Two shafts, of 10 feet diameter, for the cylinders.

	Thickness.	Depth.
	Ft.	Ft.
Foreshore shingle	10	10
[Alluvium ?] Sandy clay	9	19
[River Drift ?] Red ballast, pea-size	9	28
[Woolwich Beds ?] Soft sandstone, many colours	21	49
White [Thanet] sand, very hard at first, but loose lower down; with flints at the base	47	96
Chalk with layers of flint (two marked, in upper part)	22	118

3. South Eastern Railway. Angerstein's Wharf.

Communicated by Mr. J. B. Redman (from Mr. T. Deane, S.E.R. Engineer, 1885).

15 feet below T.H.W.M.

Mud [Alluvium]	... ...	7	19 feet.
[Valley Drift]	Ballast	10½	
	Quicksand, to Chalk	1½	

4. East Greenwich.

Communicated by Mr. J. B. Redman.

1. Mowlem & Co.'s Wharf. (1855.) 6 feet below T.H.W.M.

		Thickness.	Depth.
		Ft.	Ft.
Mud [Alluvium]	... ...	10½	10½
[Valley Drift]	Fine sand ...	2½	13
	Loam ...	2	15
	Gravel ...	1½	16½

2. Boat Building Co.		Thickness.	Depth.
		Ft.	Ft.
Soil	... ...	2½	2½
Alluvium	Clay	9½	12
	Peat	1	13
[ValleyDrift]	Fine sand	3½	16½
	Coarse sand, to gravel	1	17½

5. Greenwich Marsh (? at the river-side), nearly opposite to Blackwall Pier, and opposite to Green's Dock.

From the "Sections of Borings for the proposed Tunnel Sewer, by J. Phillips, Surveyor." Large sheet (1849).

Surface 5½ feet below Trinity High Water Mark.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 20¾ feet]	Brownish clay...	3¾	3¾
	Dark grey clay	1½	5¼
	Peat	8½	13¾
	Light ash-coloured sandy marl, with traces of vegetable matter ...	5	18¾
	Dark grey clay, with Vivianite ...	2	20¾
Sand and gravel...	... ...	12	32¾
Dark grey [London ?] clay, slightly micaceous [?]...		55	87¾
[Woolwich Beds]	Sand, with fragments of shells ...	2½	90¼
	Dark grey clay	¾	91

6. GREENWICH MARSH (northern part).

Eleven borings, made and communicated by Messrs. DOCWRA.

1. At head of small creek over a quarter of a mile south-eastward of Blackwall Point.

10. Over $\frac{1}{6}$ mile a little W. of N. from the north-western end of East Place.

11. Over $\frac{1}{6}$ mile from the western shore, by Chemical Works.

		(1.)	(10.)	(11.)
		Ft.	Ft.	Ft.
[Alluvium]	Bungham [marsh-clay]	13	8	8
	Peat	$13\frac{1}{2}$	$4\frac{3}{4}$	4
Ballast [River Gravel]...		12	$25\frac{1}{4}$	$27\frac{1}{2}$
Blue [London ?] clay		$11\frac{1}{2}$	8	8
		50	46	$47\frac{1}{2}$

2. About a third of a mile northward of East Place.

		Thickness.	Depth.
		Ft.	Ft.
Bungham [Alluvial Clay]		13	13
[River Drift, 27 feet]	Ballast [gravel] ...	5	18
	Running sand	3	21
	Sand and small ballast	$2\frac{1}{4}$	$23\frac{1}{4}$
	Coarse ballast... ...	$3\frac{1}{4}$	$26\frac{1}{2}$
	Running sand	$4\frac{1}{2}$	31
	Sand and ballast ...	4	35
	Coarse ballast... ...	5	40
Blue [London] clay		12	52

3. A sixth of a mile N. of Idenden Terrace.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium]	Bungham [marsh-clay]...	$9\frac{1}{4}$	$9\frac{1}{4}$
	Peat	$6\frac{1}{4}$	$15\frac{1}{2}$
	Bungham [marsh-clay]...	$1\frac{1}{2}$	17
[River Drift]	Coarse ballast and sand	$20\frac{1}{2}$	$37\frac{1}{2}$
	Sandy clay	$1\frac{1}{4}$	$38\frac{3}{4}$
	Pebbles	$\frac{1}{2}$	$39\frac{1}{4}$
	Shells	$\frac{1}{2}$	$39\frac{3}{4}$
	Running, green sand ...	$25\frac{1}{4}$	65
	Blue clay	7	72

Perhaps the two, or three, beds next beneath the gravel may belong to the Basement-bed of the London Clay.

4. Near the eastern edge of the marsh, $\frac{1}{8}$ mile north-westward of Chemical Works, and still nearer No. 1.

5. North-eastward from East Place, about half-way to the shore, at Chemical Works.

6. $\frac{1}{8}$ mile W. of the western end of River Terrace, a little S.E. of 3.

7. Between 6 and River Terrace.

8. $\frac{1}{4}$ mile N.E. of East Place.

9. A little westward of 3.

These are fairly near together.

		4.	5.	6.	7.	8.	9.
		Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
[Alluvium]	Bungham [marsh-clay] ...	16¾	6	6¼	5	7¼	8⅔
	Peat	3¼	6½	6¾	2½	2	2⅓
	Loamy sand, or sand, or sand and loam	3¼	2½	4	10	7¾	6
[River Drift]	Ballast, or ballast and sand ...	21¼	20½	27	25½	12	20
	Sand	—	—	19	28	—	—
Blue [? London] clay		5½	6	5	2½	8	6
		50	41½	68	73½	37	43

If the sand beneath the ballast is classed with the latter this seems to give too great a thickness to the River Drift. It is possible, therefore, that the sand may be a bed beneath the London Clay, in which case, of course, the underlying clay cannot belong to that formation.

Hoo. West Hoo Creek. Borings for Swing Bridge, nearly half-way from Hoo to Hoo Fort (for War Office).

Communicated by Capt. Thos. English, R.E.

		Thickness.	Depth.
		Ft.	Ft.
Water (from high-water mark) to bed of Creek ...		15	15
[Alluvium, 22½ feet]	Mud ... ... about	5¾	20¾
	Peat ... ... ,,	2¼	23
	Silty mud	2	25
	Dark blue mud	7	32
	Peat	1	33
	Light-blue mud ... ...nearly	3	36
	Blue brown sandy mud ... about	1½	37½
[River Drift, 12½ feet]	Yellowish clayey sand, with fragments of shells and pebbles (*a*) about	7½	45
	Clayey ballast (*b*) ... ... ,,	2¼	47¼
	Light-blue silt (*c*) ... ... ,,	2	49¼
	Brown ballast (*d*) ... ... ,,	¾	50

In another of the borings (close by) bed *a* was a foot or more thinner, the bed *b* rising up and being thicker ; *c* was also less than a foot thick, *d* rising up higher.

Hougham. Shaft for Channel Tunnel.

From the MS. of a paper by H. E. Stilgoe. The Dover Watershed and Water Supply.

	Thickness.	Depth.
	Ft.	Ft.
Lower (grey) chalk ...	91	91
Hard chalk marl	39	130
Chloritic marl	8	138
Light-coloured gault ...	48	186
Dark blue gault	70	256

The work was not interfered with by percolation of sea-water, either in sinking the shaft or in driving the heading under the sea.

Kidbrooke. On the northern side of Kidbrooke Lane, a little more than half a mile S.E. of St. James' Church. 1894.

Made and communicated by Messrs. LE GRAND and SUTCLIFF.
135 feet above Ordnance Datum.

Water-level 28½ feet down.

		Thickness.	Depth.
		Ft.	Ft.
London Clay	Yellow clay	5	5
	Blue clay	50	55
	Sandy clay	17	72
Blackheath Beds.	Coarse sand and pebbles	3	75

Lewisham. THE UNION INFIRMARY, High Road. For Lift-shaft, on the Female Side. 1893.

Communicated by Messrs. HARSTON.

Original surface 40¼ feet above Ordnance Datum. Slopes to the Ravensbourne, near by, westward.

Shaft 17 feet, the rest bored and lined (to exclude water).

Water-level varied from 7 to 11 feet down.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Mould		1	8	1	8
Alluvium.	Wet peat	2	6	4	2
River Drift	Clean red sand	0	9	4	11
	Clean red pebbly flint gravel, with a little clean red sand	1	9	6	8
	Clean red sand	0	10	7	6
Woolwich Beds	Layers of pebbles, with clay and mud, alternated with blue plastic clay, with traces of shells, which increase with the depth	8	0	15	6
	Shell-bed, mostly oyster-shells ...	1	0	16	6
	Clean sandy red gravel, with flint pebbles and pieces of shells ...	7	0	23	6
	Shell-bed, loosely impacted with blue clay	3	0	26	6
	Deposit like dirty chalk, impregnated with muddy water	4	0	30	6
	Gravel, of flint pebbles and red sand, gradually changing to wet blue clay at the base	5	0	35	6
	Deposit like dirty chalk, as that above the last, but a little cleaner	4	6	40	0
	Green soft soapy dead sand, with some flint pebbles	2	6	42	6
	Yellow clayey flint pebble-gravel ...	2	6	45	0

Plumstead Marsh. East of the Practice-butt, Royal Arsenal.

From the "Sections of Borings for the Tunnel Sewer," by J. PHILLIPS, Surveyor (1849).

Surface 8¾ feet below T.H.W.M.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 24 feet]	Brown sandy clay	4	4
	Dark clay	1	5
	Peat	10	15
	Striped, grey clay	9	24
Sharp, shingly gravel		11	35
[Thanet] sand, greenish		26	61
Chalk, with courses of flint every 4 or 5 feet		36	97

St. Margaret's. Trial-boring for the Channel Tunnel Company. On the shore.

Ordn. Map 290, new ser.; Geol. Map 3.

PRESTWICH, *Proc. Inst. Civ. Eng.* 1874.

		Thickness.	Depth.
		Ft.	Ft.
Shingle ...	... ...	9	9
Upper or White Chalk, 240 feet	White chalk	209	218
	Yellow chalk	4	222
	White chalk	4	226
	Fissure (salt water)	3	229
	White chalk	20	249
Lower or Grey Chalk, 299 feet	Grey chalk	30	279
	White chalk	10	289
	Blue marl	11	300
	Pipe clay	42	342
	Light-blue clay	158	500
	Light stone	1¾	501¾
	Light clay	1½	503¼
	Stone	1¼	504½
	Clay*	2½	507
	Stone	1½	508½
	Clay*	3	511½
	Stone	1¾	513¼
	Clay*	10	523¼
	Stone	1¼	524½
	Clay*	10	534½
	Stone	½	535
	Clay*	10	545
	Greensand [= base of the Chalk Marl]...	3	548
Gault clay	... ...	19	567

Mr. JUKES-BROWNE has suggested that the beds up to 504½ feet may be Gault.

* "Clay" (in the Chalk) is probably used in the sense of marl, or nearly chalk. One is hardly disposed to accept the above classification of Upper and Lower [including Middle] Chalk, but inclined rather to end the former higher up.

Sheerness.

1. CHEYNE ROCK.

Five borings made for and communicated by the War Office.

A.

Shingle	11	48 feet
Blue clay, softer at bottom	37	

B.

Shingle...	$1\frac{1}{3}$	43 feet
Blue clay, very soft and silty below	$41\frac{2}{3}$	

C.

Shingle	3	$36\frac{1}{2}$ feet
Blue clay, about	$33\frac{1}{2}$	

D.

Surface soil	$\frac{1}{2}$	5 feet
Shingle	$1\frac{3}{4}$	
Loamy blue clay	$1\frac{1}{4}$	
Shingle, to blue clay, nearly	$1\frac{1}{2}$	

E.

	Ft	in.
Surface soil	1	0
Shingle ...	3	10

2. GARRISON POINT.

Borings made for and communicated by the War Office.
1 (had to be abandoned).
Close compact shingle 34 feet.

3.

Close compact shingle ...	35	41 feet.
Soft sandy mud [alluvial]	6	

Very great difficulty experienced. Several pieces of old timber and rubble stone met with.

3A.

14 feet of clean compact shingle.

4.

Old timber, rough rubble stone, and loose shingle	10	40 feet
Rather loose shingle...	10	
Very soft mud [alluvial]	20	

The old timber seems to have been placed there when the beach was much lower than now, to protect the foundations.

5.

Loose shingle, filled in artificially	18	40 feet
Compact black sand	14	
Quick sand, blowing up the pipe some way if the boring was left off for only half an hour...	8	

6.

Soft sandy clay, very wet and soft towards the bottom 26 feet.

7.

Soft sandy clay, very wet and soft towards the bottom 36 feet.

Stone.

On the bank of the Thames, 200 yards above the track from Littlebrook. Trial-bore, made for the projected London and Tilbury, Dartford and Kent Coast Junction Railway, 1875.

Made and communicated by Messrs. Docwra.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvium, 38 feet]	Yellow clay	1½	1½
	Light-coloured clay and sand ...	1½	3
	Black mud	13	16
	Peat	14	30
	Dark sand [this bed may perhaps belong to the gravel below] ...	8	38
Gravel; upper part light-coloured, the lower dark		20	58
[UpperChalk]	Chalk, with flints (in 10 layers, nearer together in the upper part and from 3 to 6 inches thick) about	33	91
	Chalk, without flints...	9½	100½
	Hard chalk, without flints	40	about 140

Woolwich.

1. Arsenal.

For chimney of shell-foundry. 1884?

		Thickness.	Depth.
		Ft.	Ft.
Made ground		15½	15½
[Alluvium]	Clay and sand...	3	18½
	Peat	9	27½
	Clay	4½	32
	Clay and ballast (to hard ballast)	3	35

Well at the north-eastern corner of the Arsenal, just W. of canal. Mud 16 and Clay 16 feet, to sandy gravel.

Seven borings made and communicated by Messrs. T. Docwra & Son.

1. In the river, a little way from the bank, more than a quarter of a mile below the canal.

Mud [alluvial]		2	30½ feet
Gravel		6	
[Thanet]	Sand (with flints in the bottom foot)	20½	
Chalk		2	

2. Close by, nearer the bank, mud [alluvial] 7, and gravel 13.

3. On the bank, nearer the canal.

		Thickness.	Depth.
		Ft.	Ft.
Made ground ...		8	8
[Alluvium, 25 feet]	Mud	16	24
	Peat	1	25
	Mud	8	33
Shingle [gravel] ...		7	40

4. On the bank, still nearer the canal.

		Thickness.	Depth.
		Ft.	Ft.
	Made ground	10	10
	Gravel	1	11
[Alluvium]	Mud	10	21
	Peat	8	29
	Gravel	10	39

5. On the bank, about an eighth of a mile below the canal.

		Thickness.	Depth.
		Ft.	Ft.
	Made ground	1	1
	Gravel	5	6
[Alluvium, 19 feet]	Mud	13	19
	Peat	2	21
	Clay and sand	4	25

6. In the river close to the bank, nearly half a mile below the canal.

		Thickness.	Depth.
		Ft.	Ft.
[Alluvial]	Mud	15	15
	Gravel	5	20
	Peat	2	22
[Valley Drift]	Sand	1	23
	Gravel	4	27

7. On the eastern side of the canal, by the bridge south of the gasworks, and more than a quarter of a mile from the river (where the canal joins it).

		Thickness.	Depth.
		Ft.	Ft.
	Made ground	4	4
[Alluvium, 21 feet]	Clay	1	5
	Peat	3	8
	Clay	8	16
	Peat	9	25
[Valley Drift]	Sand	9	34
	Gravel	4	38

Nos. 8 and 9 were not marked on the plan, and so their position is doubtful and they are not given.

2. ARTILLERY LANE. Thomas and Edge. War Office site.

Made and communicated (1905) by Messrs. A. WILLIAMS & Co.

	Thickness.	Depth.
	Ft.	Ft.
Sandy clay	14	14
Loamy sand	5	19
Petrified shell and Thames mud	11	30
Marl	½	30½
Grey loamy sand	11½	42
Red loamy sand	6	48
Ballast [gravel]	½	48½
Very hard red sand	6	54½

3. DOCKYARD.

Front of new Western Graving Dock. 1840, 41.

Communicated by Mr. J. B. REDMAN.
Bottom of basin 19 feet below T.H.W.M.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Alluvium]	Silt	10	0	10	0
	Sand and gravel ...	2	0	12	0
	Clean, sharp sand ...	1	6	13	6
	Silt and clay ...	2	0	15	6
[River Drift]	Hard, coarse gravel	2	2	17	8
	Hard, fine gravel ...	3	8	21	4

Communicated by Mr. J. B. REDMAN. "From R. Townsend, Admiralty Engineer. 1840."

		Thickness.	Depth.
		Ft.	Ft.
Made ground		13½	13½
Dark gravel		1	14½
[Alluvium, 24½ feet]	Dark clay...	½	15
	Light-blue clay	3½	18½
	Peat	8½	27
	Light-blue silt	7	34
	Light-blue silt and clay	5	39
Sand and gravel		4½	43½

4. FOR LONDON COUNTY COUNCIL NEW SEWERS. Three Borings.

Information from Mr. J. R. DIXON, Borough Engineer, 1907.

NORTHERN END OF EARL STREET.

Water-level 47½ feet down.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
Made ground		1	0	1	0
[Woolwich Beds]	Loamy clay	5	0	6	0
	Clay ...	5	0	11	0
	Green sand	7	0	18	0
[Thanet Sand]	Red sand ...	1	6	19	6
	White sand	45	10	65	4

ARMSTRONG PLACE.

Water-level 35 feet down.

		Thickness.	Depth.
		Ft.	Ft.
Made ground		10	10
[? Woolwich Beds]	Loamy sand ...	3	13
	Black sand ...	2	15
	Green sand ...	4	19
[Thanet Sand]	White sand ...	26	45
	Loamy sand ...	4	49
	Loamy green sand	1	50
	Green sand ...	1	51
Chalk		4	55

EASTERN END OF ARTILLERY PLACE, on Barrack Ground.

Water-level 111 feet down.

		Thickness.	Depth.
		Ft.	Ft.
[? Blackheath Beds]	Gravel	4	4
[? Blackheath, or Woolwich Beds]	Light-brown sand	10½	14½
	Sand	9½	24
[Woolwich Beds]	Blue clay and shells ...	11½	35½
	Light-grey and loamy sand	4½	40
	Grey sand	7	47
	Mottled loamy sand ...	9	56
[Thanet Sand]	Light-brown sand	51	107
	Flints	2 ?	109
Chalk and flints		23	132

ANALYSES OF SPRING WATERS.

A number of analyses of waters from springs having been collected it seems well to give these separately from the far larger number that refer to well-waters.

In some cases supplies are of a mixed character, from springs and wells, and these have been classed with the wells.

The new supply for Littlestone (at Lydd) is really got from a very shallow excavation; but it is practically a spring, for the water oozes out of the shingle close by.

Aylesford. COSSINGTON SPRINGS. Used for the supply of Maidstone. From Lower Chalk.

By H. R. GREGORY, in the *Report to the Local Government Board on the Epidemic of Typhoid Fever*, 1897, pp. 67, 74-76. ? In grains per gallon except the ammonia, which is in parts per million.

All 1897. 1, September 29th. 2, Tank No. 1, November 10th. 3, Tank No. 2, November 5th. 4, Tank No. 3, November 5th.

	1.	2.	3.	4.
Total solids	16·8	22·5	24·4	18·3
Nitrogen as nitrates ...	·34	·46	·17	·23
Chlorine	1·47	1·4	1·33	1·4
Oxygen in 15 minutes	·0028	—	·0059	·0059
,, ,, 4 hours ...	·0038	—	·0079	·0079
Ammonia, free ...	none	·02	·01	·04
Ammonia, albuminoid	slight trace	·02	·01	·02
Total hardness ...	16·8°	16·4°	13·7°	16·4°
Permanent hardness ...	4·9°	6·6°	6·3°	10·8°

All clear blue in 2-foot tube.

Boughton Malherbe. LIVERTON SPRINGS.

By H. R. GREGORY, August, 1898. Communicated by Dr. F. PARSONS.

At the junction of the Hythe Beds and the Atherfield Clay. Yield 26,640 gallons a day in August, 1898. (F. P.)

Total solids	22·	Grains per gallon.
Oxygen absorbed from permanganate in 15 minutes	·0018	
,, ,, ,, ,, ,, 4 hours ...	·0037	
Nitrogen as nitrates	·57	
Chlorine as chlorides	1·54	

Ammonia, none free, albuminoid ·01 per million.
Hardness, total 16·2°, permanent 3·7°.
Colour and appearance in 2-foot tube, clear blue tinge.

A water of very great organic purity, evidence of organic contamination being almost absent. In all respects most suitable for supply.

Boxley.

1. Spring. About 200 feet above Ordnance Datum.
From Chalk covered with about a foot of loam. April, 1899.
Made and communicated by Dr. J. C. Thresh. In parts per 100,060.

Ca. 8·7	Mg. ·3	Na.	CO_3 12·5	SO_4 ·65	Cl 2·15	NO_3 5·2	Probable combinations.	
8·35	—	—	12·5	—	—	—	Calcium carbonate	20·85
·25	—	—	—	·65	—	—	Calcium sulphate ...	·9
—	·3	—	—	—	·9	—	Magnesium chloride	1·2
—	—	·8	—	—	1·25	—	Sodium chloride ...	2·05
—	—	2·	—	—	—	5·2	Sodium nitrate ...	7·2
							Silica, etc.	1·8

Total solid constituents dried at 180°C. 34·

Organic ammonia (no free ammonia, no nitrites) ·001
Oxygen absorbed in 4 hours at 27°C. ... ... ·021

A churchyard near on higher ground possibly explains the large amount of nitrates.

2. Boarley Spring. Taken for the supply of Maidstone. From Lower Chalk.

By H. R. Gregory, in the *Report to the Local Government Board on the Epidemic of Typhoid Fever*, 1897, pp. 67, 72-74. ? In grains per gallon, except the ammonia, which is in parts per million.

All 1897. 1, drawn from Temple Court, September 29th. 2, Boarley Tank, in Wood, November 10th. 3, Boarley Tank, at part of Long Heading, Laid Valley, November 5th. 4, Boarley Well, in meadow at back of farm, November 5th. 5, Boarley Tank, at corner of orchard, November 5th.

	1.	2.	3.	4.	5.
Total solids	25·	27·6	15·	24·5	25·
Nitrogen as nitrates	·46	·69	·57	·46	·57
Chlorine	1·54	1·61	1·54	1·47	1·47
Oxygen in 15 minutes	·0019	·0019	·0029	·0019	—
„ „ 4 hours ...	·0057	·0049	·0049	·0059	·0039
Free ammonia ...	none	·02	·01	very slight trace	none
Albuminoid ammonia	·01	·04	·01	·01	·01
Total hardness ...	17·5°	18·5°	15·4°	16·1°	16·8°
Permanent hardness	5·6°	5·2°	4·2°	4·5°	4·2°

All clear blue in 2-foot tube.

Charing. Summerhouse Spring. From Chalk.

Yield insufficient for the supply of the place. March, 1896.
By M. K. Robinson, communicated by Dr. F. Parsons.
Albuminoid ammonia (no free ammonia) ·02 parts per million.

Chlorine	1·4	Grains per gallon.
Oxygen absorbed in 15 minutes	·01	
Nitrogen as nitrates	·05	

A good water, suitable for public supply.

Cheriton and Hythe.

By L. Blyth, September 1855. *Papers Corps R. Eng.*, ser. 2, vol. v., pp. 76, 79, 80. In grains per gallon. The Nos. follow those of well-water analyses (see p. 294).

4. "At Seabrook, in Horne Street . . . . in a valley beneath the hill on which the camp was formed. It flows out from a wall at the foot of the opposite hill. . . . It sends forth a constant stream, which at a rough guess may be averaged at about 20 gallons per minute, and runs to waste in a neighbouring mill stream."

5. "On the side of the hill, on which the camp is at present placed, at Hythe."

6. "Spring used by the soldiers at the present camp, at Hythe."

All from Kentish Rag.

	4	5	6
Chloride of magnesium ...	1·12	trace	trace
Chloride of calcium	trace	trace	trace
Chloride of sodium	4·26	2·43	2·86
Carbonate of magnesia ...	1·78	2·45	1·98
Carbonate of zinc [lime] ...	16·38	14·7	15·36
Silica	3·62	3·08	3·24
Iron	trace	trace	trace
Sulphates	trace	trace	trace
Nitrates	—	trace	—
Ammonia	—	—	—
Organic matter	trace	trace	·78
Total soluble matter	27·16	22·66	24·22

Mechanical impurity; in 4 no deposit; in 5 very slight deposit (grit, confervæ); in 6 slight deposit (grit, confervæ).

Of 4 it is said: "The solid constituents partake of the character of the rock from which it issues, and consist principally of lime, which is soluble in carbonic acid." It is clear therefore that the alarming entry of zinc is a printer's error. "The water contains a large quantity of carbonic acid in a free state, . . but on exposure to the air, this gas flies off, and the lime which it held in solution will be deposited in an insoluble form."

4. "The water . . was bright, cool and sparkling . . agreeable and refreshing to the taste."

5, 6. "The samples . . although not so bright . . were entirely free from bad taste or smell."

East Barming. Springs formerly taken for the supply of Maidstone. From Lower Greensand.

By M. A. Adams, in the *Report to the Local Government Board on the Epidemic of Typhoid Fever*, 1897, pp. 64, 65.

From catch-pits 1 to 11, by the South Eastern Railway. Of these 6= Little Church spring, 7=Big Church spring, 8=Church End spring, 9= Hospital spring, 10=Underbank spring, 11=End spring. The samples from 1 to 5 were taken on September 20th, the rest on September 25th.

It is enough here to give the highest and lowest figures, without going into details for each case. The results are in grains per gallon, except the ammonia, which is in parts per million.

Total solids	36·9 (in 9) to 49·7 (in 11)
Loss on ignition	·8 (in 5) to 5·2 (in 2)
Chlorine	2·1 (in 1) to 3·3 (in 4)
Nitrogen as nitrates and nitrites	·57 (in 6) to 1·52 (in 1)
Albuminoid ammonia (no free) ...	none (in 4, 7, 9) to ·3 (in 5)
Oxygen absorbed in ¼ hour ...	·003 (in 1) to ·1 (in 5)
,, ,, ,, 4 hours ...	·015 (in 6, 7, 9) to ·32 (in 5)
Phosphoric acid	very slight trace (in 6) to moderate trace (in 3, 8, 10)
Total hardness	17·2 (in 9) to 23·4 (in 11).
Permanent hardness	8·2 (in 2, 5) to 10·6 (in 11)

Two-foot tube, clear bluish-green, clear greenish-blue, or clear green, in all but 5, which was green and slightly turbid.

No smell in any.

Appearance of residue on ignition, from "slightly blackens and fuses" (in 1, 2) to "very black and fuses" (in 8).

Slightly different results are given by H. R. GREGORY on p. 66 of the *Report*, and some of his samples were taken on September 22nd. It seems needless to reproduce these.

Folkestone. SPRINGS at Cherry Gardens. From Lower Chalk. February 28th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 123. Repeated p. 343.
Clear and palatable. Temperature 11°C.

Total solid impurity	32·14	Parts per 100,000.
Organic carbon	·025	
Organic nitrogen (no ammonia)...	·004	
Nitrogen as nitrates and nitrites	·313	
Total combined nitrogen... ...	·317	
Chlorine	2·9	

Hardness, temporary 21·3, permanent 5; total 26·3.

Other analyses, of samples that must have been partly spring-water, are given on pages 305-307.

Fordwich. Public supply.

Communicated by Dr. F. PARSONS.

Spring in Thanet Sand, from cultivated ground. Yield averages 300 gallons an hour.

By Mr. S. HARVEY, February, 1898. From the reservoir. In grains per gallon.

Appearance clear. No smell.

Chlorine in chlorides	2·38
Phosphoric acid in phosphates, trace	
Nitrogen in nitrates	·93
Ammonia	·0007
Albuminoid ammonia	·0031
Oxygen absorbed in 15 minutes, trace only	
Oxygen absorbed in 4 hours	·032
Total solid matter	21·03

Hardness before boiling 12·9°, after boiling (permanent) 6·6°.

Microscopical examination of deposit. Slight and unimportant.

"The nitrates figure is still rather high, but the general results compare favourably with those of the two previous analyses [not now given] and indicate water of fair organic purity."

Hougham. LYDDEN SPOUT. On the coast southward of the village. From Chalk.

Made and communicated by Mr. C. EKIN. In parts per million.

Total solids 321
Chlorine ... 37
Nitrogen as nitrates (no nitrites or ammonia) 2·63.
Hardness, Clark's scale, 14·5°.

Hythe.

1. THE BREWERY. From Lower Greensand. In grains per gallon.

Communicated by Mr. W. R. MACKESON (1878).

Mineral matter ... 31·76 } Total solid matter 33·76
Volatilized matter 2· } grains per gallon.
Hardness before boiling 19·9°, after boiling 10°.

The mineral matter was of the following composition :—

Silica	·64	Grains per gallon.
Carbonate of lime ...	13·65	
Sulphate of lime ...	6·42	
Nitrate of lime ...	2·03	
Carbonate of magnesia	2·2	
Chloride of potassium	1·2	
Chloride of sodium...	4·08	
Carbonate of sodium	1·54	

2. Waterworks. An analysis of a sample in part spring-water is given on p. 321.

3. Sandgate Waterworks. From Lower Greensand, see p. 65.

By R. Bodmer. Communicated by Dr. F. Parsons.

Total solids, dried at 120°C.	33·04	Grains per gallon.
Combined chlorine (=Na Cl. 5·45) ...	3·3	
Nitrogen as nitrates (no nitrites) ...	·11	
Saline ammonia	·0004	
Albuminoid ammonia	·0033	
Oxygen absorbed in 4 hours at 27°C.	·016	

Hardness 20·08°.

A water of satisfactory organic purity.

An earlier analysis of the water of the Honeywood Spring, February 28th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 121. Clear and palatable. Temperature 12°C.

Total solid impurity...	46·74	Parts per 100,000
Organic carbon	·057	
Organic nitrogen (no ammonia) ...	·007	
Nitrogen as nitrates and nitrites	·358	
Total combined nitrogen	·365	
Chlorine	5·2	

Hardness, temporary 20·8, permanent 8·9, total 29·7.

The following, by G. W. Wigner, in *The Water Supply of Sea-side Watering-places*, 1878, p. 39, is presumably from the same source, though he was under the impression that the supply came partly from the Folkestone Works at Cheriton. The sample was drawn from a main tap. Results in grains per gallon.

Total solid matter	34·6
Loss on ignition after deducting combined carbonic acid	4·37
Chlorine calculated as chloride of sodium...	6·2
Nitrogen as ammonia	·0022
,, ,, albuminoid ammonia	·0023
,, ,, nitrates	·109
,, ,, nitrites	·003
Total nitrogen in these four forms	·1165
Oxygen absorbed by organic matter	·012

Hardness, Clark's scale, before boiling 17·8°, after boiling 4·5°.

Pale blue; fair smell. Microscopic results very satisfactory. A very good supply.

Lydd. Littlestone-on-Sea. New Water Supply. From Shingle, see p. 65.

By Sir T. Stevenson, in grains per gallon.
Communicated by Mr. A. F. Phillips.
Sample taken from supply-tap in New Romney, 26th February, 1907.
No colour, odour or turbidity.

Soda (Na_2O)	1·37
Potash (K_2O), traces	
Lime (CaO)	2·01
Magnesia (MgO)	·49
Iron oxide (Fe_2O_3)	·06
Chlorine	1·39
Sulphuric acid (SO_3)	·55
Nitric acid (N_2O_5) traces. No nitrous acid (N_2O_3)	
Combined carbonic acid (CO_2)	1·97
Silica (SiO_2)	·42

Total solid residue, dried at 148°C. given as 8·46.

These constituents may be arranged as follows:—

Sodium chloride	2·29	[Total 7·91 Grains per gallon.]
Sodium sulphate	·37	
Potassium chloride, traces		
Calcium sulphate	·58	
Calcium carbonate	3·16	
Magnesium carbonate	1·03	
Iron oxide	·06	
Silica	·42	

Hardness, Clark's scale, temporary 4·3°, permanent ·6°; total 4·9°.

"A good pure water. It contains little saline matter, but enough to prevent its acting as a solvent on lead. . . The organic purity is high and no contamination could be detected. Further the water is non-ferruginous, colourless, bright and of beautiful appearance."

Perhaps the small amount of common salt is chiefly due to spray from the sea being carried across the shingle.—W. W.

Maidstone. Springs supplying the town. From the Chalk August 8th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 127.

Given as an example of a polluted spring-water [locality not given: so there is some doubt. The Chalk-springs now used yield a good water. —W.W.]

Slightly turbid. Palatable. Temperature 18°C.

Total solid impurity	39·16	Parts per 100,000.
Organic carbon	·138	
Organic nitrogen	·044	
Ammonia	·004	
Nitrogen as nitrates and nitrites	·87	
Total combined nitrogen	·917	
Chlorine	3·5	

Hardness, temporary 20·8, permanent 7·1; total 27·9.

Northfleet or **Southfleet.** Springhead, January 17th, 1873. From the Upper Chalk.

Rivers Pollution Commission. Sixth Report, 1874, p. 123.

Clear and palatable. Temperature 9·2° C.

Total solid impurity	39·3	Parts per 100,000.
Organic carbon	·059	
Organic nitrogen (no ammonia)	·011	
Nitrogen as nitrates and nitrites	·863	
Total combined nitrogen	·874	
Chlorine	2·5	

Hardness, temporary 23·2, permanent 7·1, total 30·3.

Pembury.

Spring from Hasting's Beds, July 7th, 1870.

Rivers Pollution Commission. Sixth Report, 1874, p. 121.

Clear and palatable. Temperature 15·5° C.

Total solid impurity	12·26	Parts per 100,000.
Organic carbon	·002	
Organic nitrogen (no ammonia)	·004	
Nitrogen as nitrates and nitrites	·496	
Total combined nitrogen ...	·5	
Chlorine	2·83	

Hardness, temporary none, permanent 3·3.

Penshurst.

TUBB'S HOLE. Spring used for public supply. (See p. 67.) Water from Tunbridge Wells Sand.

By Dr. M. A. ADAMS, December 1899.
Communicated by Dr. F. PARSONS.

Total solids	11·8	Grains per gallon.
Loss on ignition	·9	
Chlorine	1·4	
Nitrogen as nitrates (no ammonia)	·24	
Ozygen absorbed in 15 minutes...	·008	
Oxygen absorbed in 4 hours ...	·015	
Phosphoric acid, slight trace		

(A copy from Mr. T. HENNELL gives the total solids as 11·2.)
Hardness, total 6·7°, permanent 4·7°.

Appearance in 2-foot tube, pale clear green. No smell. An excellent water.

Petham.

NAILBOURNE-WATER. Taken at a strong spring. From the Chalk.

W. H. HAMMOND. 22*nd Rep. E. Kent N.H. Soc.*, p. 24 (1880).

Total solids	22·	Grains per gallon.
Chalk	14·42	
Nitric acid	1·25	
Chlorine	1·24	
Free ammonia	·01	Parts per million.
Albuminoid ammonia...	·03	
No nitrites.		

For analysis of water from neighbouring wells see p. 332.

Pluckley.

SPRING from Lower Greensand, at the junction of the Hythe Beds with the Atherfield Clay.

Communicated by Dr. F. PARSONS.
Yield 12·24 gallons a day, May 14th, 1896.
Analysis by M. K. ROBINSON, from Spring Head, November 4th, 1896.

Total solids	28·	Grains per gallon.
Chlorine	2·11	
Oxygen used in 15 minutes, none		
Nitrates, traces		
Ammonia	·02	Parts per million.
Albuminoid ammonia	·003	

" Good and very suitable for drinking-purposes."

Sandgate.

CAMP ROAD SPRINGS. From Lower Greensand. February 28th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 127.

Given as an example of a polluted spring-water.

Clear and palatable. Temperature 10·8° C.

Total solid impurity	36·9	Parts per 100,000.
Organic carbon	·146	
Organic nitrogen	·03	
Ammonia	·001	
Nitrogen as nitrates and nitrites	·955	
Total combined nitrogen ...	·986	
Chlorine	5·95	

Hardness, temporary 6·9, permanent 9·7 ; total 16·6.

WATERWORKS, see under **Hythe**.

Sevenoaks. MR. SPOTTISWOODE'S SPRING, August 8th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 123. Repeated p. 294.
Slightly turbid. Palatable.

Total solid impurity	34·4	Parts per 100,000.
Organic carbon	·053	
Organic nitrogen (no ammonia)	·009	
Nitrogen as nitrates and nitrites	·277	
Total combined nitrogen ...	·286	
Chlorine	1·3	

Hardness, temporary 25·3, permanent 6·9 ; total 32·2.

Tunbridge Wells.

Water from Tunbridge Wells Sand.

1. BATCHELOR'S SPRING. 2. COLLIN'S SPRING.

By Sir T. STEVENSON, May, 1899. Communicated by Dr. F. PARSONS.

Both from the junction of the Tunbridge Wells Sand and the Wadhurst Clay. In grains per gallon.

	1.	2.
Total solid matter	6·16	10·08
Loss on ignition	·28	1·96
Combined chlorine	1·4	1·54
Equal to common salt...	2·31	2·54
Nitrogen as nitrates (no nitrites)	·15	·73
Ammonia	·0005	traces
Albuminoid or organic ammonia	·0025	·001
Oxygen required to oxidise organic matter	·007	·006

Hardness in 1, 2·7° ; in 2, 5·7°.

Both free from odour and when viewed in bulk colourless and clear. Excellent non-ferruginous waters of small salinity and of the highest degree of organic purity, well fitted for supply.

Very many analyses of Tunbridge Wells Springs are given in the multitude of works on those waters.

3. The Chalybeate Spring. (See p. 45.)

By J. Thomson, in grains per gallon. *Journ. Chem. Soc.*, 1858, vol. x., pp. 223-229. Reprinted in "The Geology of the Weald," 1875, p. 353.

Sulphate of lime	2·1
Carbonate of lime	·4494
Carbonate of magnesia	1·1172
Chloride of potassium	·2345
Carbonate of potassa	5·978
Chloride of sodium	3·178
Carbonate of iron	3·9123
Carbonate of manganese, trace	
Silica	·525
Organic matter, trace	—
Total	12·1142

West Farleigh.

Springs, from Lower Greensand, formerly taken for Maidstone Waterworks.

By M. A. Adams in the *Report to the Local Government Board on the Epidemic of Typhoid Fever*, 1897, pp. 64, 65.

Results in grains per gallon, except the ammonias, which are in parts per million. Some analyses of mixed waters are also given.

	Tutsham-in-field.		Tutsham in-orchard.	Ewell. Injection-tank.		Ewell. Air-pipe.
	Sept. 19th.	Oct. 19th.	Nov. 16th.	Sept. 19th.	Oct. 19th.	Oct. 29th.
Total solids	39·5	38·5	34·8	23·2	22·9	23·1
Loss on ignition ...	3·8	4·9	2·6	1·5	1·9	3·2
Chlorine	2·5	2·1	1·9	2·	1·8	1·8
Nitrogen as nitrates and nitrites ...	·71	·81	·68	·7	·62	·38
Free ammonia ...	none	·01	none	none	none	none
Albuminoid ammonia	·13	·17	·02	·07	·02	·02
Oxygen absorbed in ¼ hour	·012	·01	·003	·005	·007	·004
Oxygen absorbed in 4 hours	·023	·02	·012	·017	·01	·008
Phosphoric acid ...	moderate trace	heavy trace	slight trace	slight trace	very heavy trace	moderate trace
Total hardness ...	18·7	22·	18·5	12·7	14·	12·9
Permanent hardness...	11·3	8·9	8·7	6·3	5·5	5·3
Two-foot tube ...	green, very turbid	opaque brown very dirty and bad	clear bluish-green	clear green	pale clear blue	pale clear blue
Smell	slight	none	none	none	none	none
Appearance of residue on ignition	blackens and fuses	very black and fusing, bad looking	slightly blackens	blackens	fuses and slightly blackens, rather bad	moderately blackens

Slightly different results are given by H. R. GREGORY on pp. 66, 76-79 of the same Report; but it is needless to reproduce these here. Some of the dates differ from the above.

Another analysis, by Dr. A. HARDEN, "from Ewell springs direct, 27th October," is as follows (same Report, p. 69):—

Total solids	32·2
Chlorine	2·9
Alkalinity (expressed as Ca CO_3)...	16·5
Albuminoid ammonia (no free ammonia),	trace
Nitrogen as nitrates (no nitrites)...	·63
Oxygen absorbed from permanganate in 15 minutes and in 4 hours	0

"Remarkably free from organic matter." But the figure for oxygen absorbed seems to me impossible.—W. W.

West Malling.

ST. LEONARD'S SPRING, August 8th, 1873. From Lower Greensand.

Rivers Pollution Commission. Sixth Report, 1874, p. 121.

Clear and palatable. Temperature 10° C.

Total solid impurity	29·72	Parts per 100,000.
Organic carbon	·034	
Organic nitrogen (no ammonia)	·007	
Nitrogen as nitrates and nitrites	·151	
Total combined nitrogen ...	·158	
Chlorine	2·2	

Hardness, temporary 20·7, permanent 3·5; total 24·2.

ANALYSES OF WELL WATERS.

In submitting the following fairly large collection of analyses, attention is drawn to the fact that these are of very unequal value. It is not common to get a finished mineral analysis, which of course is what the geologist wants, as enabling him to trace the history (and sometimes troubling him with the mystery) of a water. Nevertheless, the less detailed analyses are of much value.

Again, amongst the analyses given there are many of respectable age, and referring to wells not now existing or not now used. But it seems to the writer that these too are of interest, as connected with a past state of things and as illustrating some advance in sanitary work. The story of the past is often of interest.

Some of the detailed analyses, as those from Ashford and Hadlow, are not easy to understand; it is indeed hard to explain the presence of some of the salts in such quantity as is shown.

Printed records have been examined, but there must be many others unknown to the writer, and of which he would like to be told. Many unpublished analyses have been communicated, largely by Dr. Thresh and Dr. Parsons; but there must be a great number of others hidden away in the records of various water-undertakings and unknown to anyone but their owners. The writer appeals to persons who have such information to communicate it, so that it may form part of a Supplement to this Memoir, when the occasion arises for such a publication.

One cannot but regret that chemists put forward their results in such diverse ways. It would be a great labour to reduce the following analyses to one form; and indeed it could hardly be done for all.

As with wells and borings the following analyses are arranged in the alphabetical order of places.

Ash. The Brewery. (See p. 73.)

Communicated by Messrs. Gardner.

Made by Mr. S. Harvey, of Canterbury, November, 1900.

Sample clear, of a blue-green when viewed through the 2-foot tube. Devoid of smell.

Mineral Analysis (in grains per gallon).

Calcium sulphate	5·47
Calcium carbonate	11·73
Magnesium carbonate	7·71
Magnesia (probably as silicate)	·14
Silica	1·54
Iron oxide, trace only, and Loss	·51
Potassium chloride	1·51
Sodium chloride	4·01
Total mineral matter ...	32·62

Carbonic acid gas, free and as bicarbonate, 17·18 cubic inches.

Organic Analysis.

Chlorine in chlorides	2·87
Phosphoric acid in phosphates, absent (practically)	—
Nitrogen in nitrates	·03
Ammonia, albuminoid	·0018
Ammonia	·0252
Oxygen absorbed in 15 minutes, trace only	—
„ „ 4 hours	·038
Total solid matter	33·25

Hardness before boiling 26°, after boiling 2°, Clark's scale.

Alkalinity, expressed in terms of carbonate of lime, 20·9, almost all removable by boiling.

The water contains a fair amount of gypsum (6·92 grains per gallon) and more magnesia-salts than usual in waters of the district. Organically it is very pure and the nitrates very low. There is no evidence therefore of sewage-percolation, either past or present, and the unusual figure for ammonia is due to the formation from which the water originates and should cause no anxiety. Altogether the water is admirable for general brewing-purposes.

[Although the boring reaches to the Chalk, it would seem that some of the water must come from the Tertiary sand.—W. W.]

Ashford.

1. Brewery. New boring. (In Hastings Beds. See p. 75).

Three analyses communicated by Messrs. Isler & Co.

By Messrs. J. M. Collett & Co., of Gloucester. 1901.

Sample received June 27th.

Free or saline ammonia	·38	Parts per million.
Albuminoid ammonia	·048	„ „
Chlorine	58·45	Grains per gallon.
Sulphuric anhydride	7·31	
Carbonate of lime (no other lime) ...	7·06	
Magnesia	·41	
Soda and potash, calculated as soda ...	67·37	
Saline residue	139·16	
Organic and volatile matter	2·18	
Total solid residue at 212° F.	141·34	
Suspended chalk and siliceous matter	25·81	

No nitric anhydride or nitrous acid.

"The water was filtered before determining the saline residue."

"The following represents the most probable saline constitution":—

Calcic carbonate ...	7·06	Grains per gallon.
Magnesic carbonate	·86	
Sodium sulphate ...	12·73	
„ carbonate ...	21·81	
„ chloride ...	96·44	

Sample opalescent. Water fairly pure with regard to organic matter, "since relative proportion of ammonia separated by Wanklyn's test might be considered normal to deep bore-hole supplies drawn from the Chalk below the London Basin Clay."

"Large proportion of sodium chloride sufficient indeed to condemn the supply for use in Ale or Beer production. It is probable, however, that steady pumping will effect a reduction in the . . . dissolved salts."

"The existence of both Sulphate and Carbonate of Sodium constitutes a noticeable feature and we can only infer that sea-water has percolated into . . . the water-bearing strata." [This however can hardly be the case, as the well is nearly ten miles from the nearest sea. The fact that the Hastings Beds are not of marine origin adds to the difficulty of explaining the large amount of sodium-chloride in this water.]

By Messrs. Sutton and Phillips, of Stowmarket. July 18th, 1901.

In grains per gallon.

Free ammonia	·059
Albuminoid ammonia	·008
Oxygen absorbed in an hour	·135
„ „ 3 hours	·156
Nitrogen, as nitrates and nitrites (= nitric acid, 3·856)	·857
Chlorine	61·6
Carbonic anhydride	11·7
Sulphuric anhydride	4·71
Lime	·56
Magnesia	·63
Potassium	25·67
Sodium	39·91
Silica	1·54

No oxides of iron or alumina.

Hardness before boiling 3°, after boiling 2°.

"The mineral constituents are probably combined as follows":—

Carbonate of lime	1·
„ „ magnesia	1·32
„ „ potash	33·14
Sulphate of potash	10·24
Nitrate of potash	6·14
Chloride of sodium	101·54
Silica	1·54
Total mineral constituents	154·92 (given as 154·89)

"The Free Ammonia in this water is very high, and as the Nitrogen exists principally as Nitrite . . . it cannot be regarded as a water safe to use for drinking purposes. We think however that so far as the Organic matter is concerned that the water will very much improve by pumping."

"Its mineral constituents are of a very peculiar nature."

By G. H. Morris. Sample received September 20th, 1901.

Appearance cloudy and slightly yellow. Taste saline. Smell earthy. Reaction alkaline. Sediment consisted entirely of mineral matter.

Ammonia, free and saline	1·09	parts per million.
„ albuminoid	·01	„ „
Oxygen absorbed in 20 minutes	·07	„ „
„ „ „ 3 hours	·17	„ „

Total solid matter (volatilisable ·42, the rest not) 139·86 grains per gallon.

The solid matter contained the following basic and acid bodies:—

Silica	·56	Grains per gallon.
Alumina	·17	
Oxide of iron	·04	
Lime	1·06	
Magnesia	·71	
Soda	71·45	
Potash	1·5	
Chlorine	60·62	
Nitric acid	·13	
Sulphuric acid	4·61	

"The above . . . would exist . . . combined together, in all probability, as under":—

Sodium chloride	99·9	Grains per gallon.
„ nitrate	·2	
„ sulphate	5·91	
„ carbonate	27·1	
Potassium sulphate	2·78	
Calcium carbonate	1·89	
Magnesium „	1·49	
Silica, &c.	·77	

"This water is pure and shows no evidence of any contamination. The total solid matter is however very high and consists mainly of soda-salts, especially chloride. The water for this reason would be unsuitable for many purposes"; quite unfitted for brewing.

2. WATERWORKS. (See p. 77.)

a From well, April, 1870. *b* From No. 2 Henwood well, 21 feet deep, February 28th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 97. In parts per 100,000.

Both slightly turbid, palatable. Temperature of *b*, 11·3° C.

	a	*b*
Total solid impurity	40·	36·32
Organic carbon	·085	·063
Organic nitrogen	·015	·01
Ammonia	·002	·004
Nitrogen as nitrates and nitrites	—	·008
Total combined nitrogen	·017	·021
Chlorine	2·8	2·8

a Hardness, temporary 27·8, permanent 6·4; total 34·2.
b „ „ 19·2 „ 7·7 „ 26·9.

From the pumping well at Henwood.

Communicated by Dr. F. PARSONS, from the Report of the Medical Officer of Health for 1903. ? Made by the Clinical Research Association.

Complaints have been made on account of a red deposit of oxide of iron being precipitated on exposure. The precipitate is not injurious to health. Hardness, 27·038.

Total solids	40·2	Grains per gallon.
Combined chlorine...	2·5	
Chlorine expressed as chloride of sodium	4·12	
Saline ammonia	·0025	
Albuminoid ammonia	·0031	
Oxygen absorbed	·016	

No nitrates or nitrites.

Beckenham. SHORTLANDS PUMPING STATION OF THE METROPOLITAN WATER BOARD. (See p. 81.) Water from the Chalk.

February 8th, 1873. *Rivers Pollution Commission. Sixth Report,* 1874, p. 101. Repeated pp. 275, 293.

Turbid, from workmen in adjoining well. Palatable. Temperature 11·5° C.

Total solid impurity	30·64	Parts per 100,000.
Organic carbon	·021	
Organic nitrogen (no ammonia)...	·007	
Nitrogen as nitrates and nitrites	·354	
Total combined nitrogen	·361	
Chlorine	1·6	

Hardness, temporary 19·3, permanent 4·6; total 23·9.

By Dr. A. J. BERNAYS, July, 1878. Sir F. BOLTON'S "London Water Supply," 1884, p. 81. There are several analyses of the organic matters, &c., on p. 83.

Sodium chloride ...	1·51	Total 22·58 grains per gallon.
Potassium sulphate	·12	
Calcium chloride ...	·3	
Calcium sulphate...	2·45	
Calcium nitrate ...	·58	
Calcium carbonate	15·82	
Magnesium nitrate	·85	
Silica	·95	

Hardness before boiling 16·28, after boiling 7·72.

Belvedere, *see* Erith, p. 303.

Benenden. Hemsted Park. February 28th, 1874. From Hastings Beds.

Rivers Pollution Commission. Sixth Report, 1874, p. 98. In parts per 100,000.

	1. Principal well, 100 feet.	2. Well in dairy-yard, 60 feet.
Total solid impurity	54·56	33·
Organic carbon	·067	·04
Organic nitrogen (no ammonia)	·017	·009
Nitrogen as nitrates and nitrites	·83	·307
Total combined nitrogen ...	·847	·316
Chlorine	9·3	9·95

1. Hardness, temporary 17·2, permanent 15·3 ; total 32·5.
2. „ „ 6·7, „ 11·6 ; „ 18·3.

Temperature, in 1, 11°C., in 2, 11·5°.

Bexley. Wansunt Well of the Metropolitan Water Board. August, 1903. (See p. 85.) Water from the Chalk.

By H. J. Helm. Communicated by Dr. F. Parsons.

Water perfectly clear and colourless, and the analytical results show that it is an unpolluted Chalk-water of very good quality.

Total solid matter	37·6	
Organic carbon	·035	Parts per 100,000.
Organic nitrogen	·004	
Albuminoid ammonia (no free ammonia)	·001	
Nitrogen as nitrates (none as nitrites) ...	·501	
Total combined nitrogen	·505	
Oxygen consumed in 4 hours at 80° F. ...	·007	
Combined chlorine	1·9	

Hardness, permanent 5·9, temporary 21·9 ; total 27·8.

Bobbing. Sittingbourne Waterworks. Well 400 feet deep. April 22nd, 1873. (See p. 86.)

Rivers Pollution Commission. Sixth Report, 1874, p. 101. Repeated p. 293. Clear and palatable. Temperature 11·7° C.

Total solid impurity	34·	Parts per 100,000.
Organic carbon	·131	
Organic nitrogen	·01	
Ammonia	·002	
Nitrogen as nitrates and nitrites	·343	
Total combined nitrogen	·345	
Chlorine	2·1	

Hardness, temporary 23·1, permanent 4·4 ; total 27·5.

Boughton-under-Blean.

By S. HARVEY, February, 1895. In grains per gallon.

Appearance tolerably clear. Colour in 2-foot tube, green-blue. No smell.

Chlorine in chlorides	1·61
Nitrogen in nitrates	·43
Ammonia	·007
Albuminoid ammonia	·0014
Oxygen absorbed in 15 minutes, trace only; in 4 hours	·022
Total solid matter	28·71

Hardness before boiling 22°, after boiling 2·3°.

Microscopical examination of deposit showed chalk chiefly.

The above results are satisfactory throughout and show water free from both organic and sewage impregnation. The sample may be described as a Chalk-water containing 19·7 grains of carbonate of lime per gallon, together with the usual mineral constituents, including a trace of sulphate of lime.

Boxley. FORSTAL PUMPING STATION OF THE MAIDSTONE WATERWORKS CO.

From a boring into the Hythe Beds. (See p. 88.)

Made by H. R. GREGORY, October, 1898. Communicated by the Company.

Colour and appearance in 2-foot tube, slightly turbid. After filtering bright greenish-blue tinge. The turbidity was due to a trace of oxide of iron in suspension.

Free ammonia	·02	Parts per million.
Albuminoid ammonia	·01	
Total solids	29·	Grains per gallon.
Oxygen [absorbed] in 15 minutes	·001	
Oxygen „ „ 4 hours	·0075	
Chlorine	1·12	
No nitrogen as nitrates.		

Hardness, total 16·2°, permanent 4·2°.

"The total solids were composed as follows":—

Silica	·72	Total 29 grains per gallon.
Oxide of iron	·12	
Carbonate of lime	15·7	
Sulphate of lime	1·47	
Carbonate of magnesia	5·33	
Chloride of sodium	3·	
Sulphate of sodium	2·3	
Trace of organic matter, combined water, etc.	·36	

"A water of great organic purity and in all respects an excellent water for a town-supply, and no doubt when the well gets into thorough working condition the slight traces of organic matter will be still further reduced, the trace of iron also will be removed."

Broadstairs. Public Supply. (See p. 91.) From the Chalk.

By G. W. WIGNER, *The Water Supply of Sea-side Watering-places*, 1878, pp. 28, 29.

Supply then derived from two wells, the older near the town. The water of this he condemned in 1876 (*Sanitary Record*, September 16th, p. 181), and the well was stated to be disused; but he infers that its water was still mixed with that from the other well. All the wells are in Upper Chalk.

Sample taken from a hydrant. Results in grains per gallon.

Total solid matter	65·46
Loss on ignition after deducting combined carbonic acid	3·
Iron very slight traces	
Chlorine, calculated as chloride of sodium	13·1
Nitrogen as ammonia	·0012
„ „ albuminoid ammonia	·0031
„ „ nitrates	1·298
„ „ nitrites	·017
Total nitrogen in these four forms	1·3193
Oxygen absorbed by organic matter...	·026

Hardness, Clark's scale, before boiling 17°, after boiling 6·5°.

The water was a good pale blue and had no objectionable smell, but a distinctly saline taste.

Microscopic results very unsatisfactory. A large number of living organisms present, mostly monads and a few small particles of animal débris. Nitrates twice as much as in unpolluted wells in the district.

The following is a more detailed analysis :—

Total saline residue ...	252·9	Grains per gallon.
Lime	29·2	
Magnesia	9·4	
Soda	89·2	
Sulphuric acid (anhydride)	41·5	
Chlorine	94·8	
Iron, trace.		

Probable constitution of saline residue.

Chloride of sodium ...	156·2	Grains per gallon.
Sulphate of soda	14·7	
Sulphate of lime	38·4	
Carbonate of lime	23·8	
Carbonate of magnesia	19·8	

Free ammonia	180	Parts per million.
Albuminoid ammonia ...	15	

Canterbury.

From shallow-wells.

1. Near Gasworks, January 30th, 1871. 2. Public Pump in Cobden Place, November 4th, 1870. 3. Public Pump in passage out of Sun Inn Yard, November 4th, 1870. [Old and abandoned wells.]

Rivers Pollution Commission. Sixth Report, 1874, p. 83. In parts per 100,000.

	1.	2.	3.
Total solid impurity	65·76	68·12	108·
Organic carbon	·249	·047	·156
Organic nitrogen	·096	·023	·143
Ammonia	·165	·024	.405
Nitrogen as nitrates and nitrites	1·707	2·362	4·946
Total combined nitrogen	1·939	2·405	5·422
Chlorine	5·18	6·6	13·1
Hardness, temporary	22·9	27·7	30·
„ permanent	14·3	9·4	24·3
„ total	37·2	37·1	54·3

1. Very turbid. 2. Clear and palatable. 3. Clear.

WATERWORKS, *see* **Thanington.**

Capel-le-Ferne. STANDEN PUMPING STATION of the Folkestone Water Co. (In Chalk. See p. 97.)

By MR. S. HARVEY, December, 1906.

Communicated by Mr. H. TURNER, Engineer to the Company (and in Water Works Directory, 1907).

Chlorine in chlorides	1·82	Grains per gallon.
Nitrogen in nitrates	·14	
Ammonia	·0004	
Albuminoid ammonia	·0011	
Oxygen absorbed in 15 minutes, trace only	—	
Oxygen absorbed in 4 hours	·016	
Total solid matter	22·89	

Clear, green-blue, no smell.

Hardness before boiling 18·9°, after boiling 3·1°.

Microscopical examination of deposit. Slight and unimportant.

"The above results are satisfactory throughout and indicate water organically pure and free from sewage-percolation."

Another analysis of the new supply for Folkestone, made and communicated by Mr. C. EKIN.

Chlorine	28·	Parts per million.
Ammonia	·02	
Nitrogen as nitrates (no nitrites)	2·8	

Charing. SUMMERHOUSE WELL. Now belongs to the Mid-Kent Co. (In Chalk. See p. 97.) June, 1899.

Made at the Agricultural College, Wye. Communicated by Dr. F. PARSONS.

In parts per 100,000.

Total solids	31·92
Nitrogen as free ammonia (none as nitrites or nitrates)	·012
Nitrogen as albuminoid ammonia	·0072
Oxygen absorbed	·016
Chlorides (as chlorine)	2·

No phosphates. Calcium-salts abundant. Magnesium-salts in some quantity. Sulphuric acid as sulphate, slight. Iron in some quantity.

Colour in 2-foot tube after filtration very faint green.

Water very turbid when received: analysis made on filtered sample.

Shows every evidence of organic purity and suitability for drinking-purposes, though rather hard for washing.

Charlton.

1. ALBION CHEMICAL CO. Riverside. 1903.

Communicated by Mr. C. BEADLE.

Silica	1·61	Total 111·76 Grains per gallon.
Oxide of iron	1·75	
Sulphate of lime	29·32	
Carbonate of lime	21·83	
Chloride of magnesium	5·85	
Carbonate of magnesia	2·84	
Chloride of sodium	48·56	

Hardness, temporary 14·98°, permanent 37·03°; total 52·01.

2. Well at Kent Water Co.'s Works, Feb. 11th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 106. Repeated p. 275 Given as an example of polluted water from a deep well in the Chalk. Clear and palatable. Temperature 11·8° C.

Total solid impurity	92·8	Parts per 100,000.
Organic carbon	·139	
Organic nitrogen (no ammonia)...	·028	
Nitrogen as nitrates and nitrites	·901	
Total combined nitrogen ...	·929	
Chlorine	19·7	

Hardness, temporary 21·3, permanent 21·3; total 42·6.

Both the pumping-stations at Charlton have been abandoned for many years. It seems clear that heavy pumping has resulted in the drawing in of water from the Thames, close by. I believe that the great sewer, made by the Metropolitan Board of Works, which runs very close to the works, has also been alleged to have done some harm to the water.—W. W.

Chatham.

1. Two analyses, by a volumetric process.

By E. Nicholson. *Journ. Chem. Soc.*, 1862, vol. xv., p. 475.

A. Water supplied to Fort Pitt by the Water Co.

Carbonate of lime ...	16·905	20·139 grains per gallon.
Carbonate of magnesia	·406	
Carbonate of soda ...	·329	
Chloride of sodium ...	2·247	
Oxide of iron... ...	·112	
Silica	·14	

B. Water from a pump at Fort Pitt.

Carbonate of lime ...	5·915	10·682 grains per gallon.
Carbonate of magnesia	·203	
Carbonate of iron ...	·973	
Sulphate of magnesia ...	1·428	
Sulphate of soda ...	·693	
Chloride of sodium ...	1·47	

Presumably both are Chalk-waters and the difference between them is remarkable.

2. Chatham, Rochester, &c., Waterworks. (See p. 103.)

Water from the Chalk, except in the last case, by Dr. Thresh, p. 294.

By Mr. D. Campbell, March. 1859.

This water is very bright, colourless, fresh and pleasing to the taste. Hardness before softening 18·66°, after softening 2·95°.

	Mineral Matter.	Volatilized or Carbonized Matter.	Total Solid Contents.
In grains per gallon at 62° F. ...	24·8	·56	25·36
After softening by the liming-process	8·24	·4	8·64

The mineral matters consist principally of carbonate of lime, with a little carbonate and sulphate of magnesia, sulphates of potash and soda and chlorides of these bases.

It is a first-class pure water.

(Several wells at Chatham were examined on a former occasion and their waters were found to contain a considerable amount of nitrates, which shows that they were much contaminated.)

From Well at Waterworks, March 8th, 1871.

Rivers Pollution Commission. Sixth Report, 1874, p. 100. Repeated p. 293.

Clear and palatable.

Total solid impurity	33·84	Parts per 100,000.
Organic carbon	·049	
Organic nitrogen	·006	
Ammonia	·001	
Nitrogen as nitrates and nitrites	·365	
Total combined nitrogen ...	·372	
Chlorine	2·4	

Hardness, temporary 22·9, permanent 4·3 ; total 27·2.

Analyses made by Prof. Dewar in 1897. In grains per gallon.

Communicated by Dr. F. Parsons.

1. Sample from Luton wells. 2. Sample from tap on town-supply.

Appearance in 1 trace of chalk, in 2 clear.
No odour in either. Reaction slightly alkaline in both. Colour of residue white in both.

	1.	2.
Oxygen required	·003	0
Nitrogen	·375	·406
Nitrogen as combined nitric acid (no ammonia)	1·687	1·827
Total solids	26·2	27·2
Chlorine (equivalent to common salt 2·478) ...	1·512	1·512

Hardness before boiling 19·89 and 20·12, after boiling 3·1 and 3·3.

Organic carbon, in parts per 100,000, ·044 and ·01.
Organic nitrogen „ „ „ ·005 „ ·004.

"These results prove that the present condition of the Chatham supply is practically identical with what it was when last examined" (rather better than when examined by Sir E. Frankland for Royal Commission on River Pollution). "The samples are exceedingly pure and free from organic impurity."

Another analysis, marked as Rochester Waterworks, November, 1897, made and communicated by Dr. J. C. Thresh, was mostly printed in his *Examination of Water and Water Supplies*, in which the silica &c. is given as 3·9 and the total solids as 42·5.

Saline constituents, in parts per 100,000.

Ca. 10·7	Mg. ·4	Na. —	CO_3. 15.	SO_4. 3·2	Cl. 3·8	NO_3. 2·2	Probable combinations.	
10·	—	—	15	—	—	—	Calcium carbonate	25·
·7	—	—	—	1·7	—	—	Calcium sulphate ...	2·4
—	·4	—	—	1·5	—	—	Magnesium sulphate	1·9
—	—	2·5	—	—	3·8	—	Sodium chloride ...	6·3
—	—	·8	—	—	—	2·2	Sodium nitrate ...	3·
							Silica, &c.	1·9

Total solid constituents, dried at 180° C. 40·5

Organic ammonia (no free ammonia) ·002.

Oxygen absorbed in 4 hours at 27° C ·015.

Another analysis, of January, 1905, made and communicated by Dr. THRESH, is of later date than the boring into the Lower Greensand, and as follows:—

Saline constituents, in parts per 100,000.

Ca. 10.1	Mg. ·3	Na. —	CO_3. 16·	So_4. ·5	Cl. 2·3	NO_3. 1·5	Probable combinations.
10·1	—	—	15·2	—	—	—	Calcium carbonate ... 25·3
—	·3	—	·8	—	—	—	Magnesium carbonate 1·1
—	—	·3	—	·5	—	—	Sodium sulphate ... ·8
—	—	1·5	—	—	2·3	—	Sodium chloride ... 3·8
—	—	·6	—	—	—	1·5	Sodium nitrate ... 2·1
							Silica, &c. ... ... 1·3

Total solid constituents, dried at 180° C. 34·4

Organic ammonia (no free ammonia or nitrites) ·001.
Oxygen absorbed in 4 hours at 27° C. ... ... ·024.

Dr. T. DUNLOP has referred (1897) to a water at Chatham, without giving the precise site, as containing 23·5 grains to the gallon of total solids, of which 17·5 were calcium-carbonate and 2·9 sodium-chloride.

Cheriton? SHORNCLIFF CAMP. Three Wells, in Lower Greensand.

By L. BLYTH, September 1855. *Papers Corps R. Eng.*, ser. 2, vol. v., p. 76.

"The soldiers having been removed to Hythe, the wells were in their most favourable condition." They "are sunk to the depth of from 100 to 150 feet (in Folkestone Beds), and water is found as soon as they arrive at the clay of the second subdivision" (Sandgate Beds).

1. Opposite Canteen No. 1 } "recently sunk and . . those most in
2. Opposite Canteen No. 2 } use by the men."
3. Cavalry-barracks, at the back of Col. Power's house. Old well, used by the cavalry.

	1	2	3
Chloride of magnesium ...	trace	trace	—
Chloride of calcium	trace	2·45	—
Chloride of sodium	10·45	12·	9·38
Carbonate of magnesia	1·46	1·24	1·35
Carbonate of zinc [lime]* ...	2·24	2·45	2·86
Silica	8·05	8·4	2·01
Iron	trace	trace	trace
Ammonia, nitrates, sulphates...	trace	trace	trace
Organic matter	3·4	3·46	1·9
Total soluble matter	25·6	30·	17·5

* Zinc is simply a misprint, lime and not zinc being noted on p. 78 of the paper.

Mechanical impurity in 1 and 2 copious deposit (grit, confervæ, infusoria); in 3 moderate deposit (grit, confervæ, infusoria, crustacea).

"All turbid, although they had not been disturbed for several days; and . . unpleasant to the taste."

2. "Had a bad smell." 3. "Would give out a bad smell if kept for 24 hours."

Cliffe. Messrs. CURTIS & HARVEY. June, 1905. (See p. 108.)
Water from the Chalk?

The mineral salts in this water are probably combined as follows, in grains per gallon.

Calcium carbonate	35·
Calcium sulphate...	15·4
Magnesium sulphate	34·8
Magnesium chloride	69·8
Sodium chloride (no sodium-carbonate or sulphate)	538·
Other salts, loss, &c.	10·
Total mineral salts	703·

This analysis points, of course, to infiltration of salt water.

Cranbrook.

1. GRAMMAR SCHOOL. (See p. 110.)

Water from Tunbridge Wells Sand. Supply abandoned.

By M. A. ADAMS, County Analyst.

Total solids ... ... 94·5 grains per gallon.
Chlorine ... ... 9· „ „ „
Free ammonia ... ·06 parts per million.
Albuminoid ammonia ·41 „ „ „
Hardness 40°, of which 26° are permanent.
Water muddy.

2. Public Supply. June, 1906.

Two analyses, made and communicated by Dr. J. C. THRESH, the first of unfiltered, the second of filtered water.

Saline constituents, in parts per 100,000.

Ca. 3·1	Mg. 1·	Fe. ·8	Na. —	CO_3. 4·8	SO_4. 5·3	Cl. 3·1	NO_3. ·25	Probable combinations.	
3·1	—	—	—	4·7	—	—	—	Calcium carbonate...	7·8
—	—	·1	—	·1	—	—	—	Ferrous carbonate...	·2
—	1·	—	—	—	3·9	—	—	Magnesium sulphate	4·9
—	—	—	·7	—	1·4	—	—	Sodium sulphate ...	2·1
—	—	—	2·	—	—	3·1	—	Sodium chloride ...	5·1
—	—	—	·1	—	—	—	·25	Sodium nitrate ...	·35
—	—	·7	—	—	—	—	—	Ferric oxide ...	1·
								Etc.	1·55

Total solid constituents dried at 180° C. ... ... 23·

3·3	·95	—	—	4·35	4·	3·4	·15		
2·9	—	—	—	4·35	—	—	—	Calcium carbonate...	7·25
·4	—	—	—	—	·95	—	—	Calcium sulphate ...	1·35
—	·75	—	—	—	3·05	—	—	Magnesium sulphate	3·8
—	·2	—	—	—	—	·55	—	Magnesium chloride	·75
—	—	1·85	—	—	—	2·85	—	Sodium chloride ...	4·7
—	—	·1	—	—	—	—	·15	Sodium nitrate ...	·25

Silica, etc. (no trace of iron) ... ... 1·4
Total solid constituents dried at 180° C. ... ... 19·5

Free ammonia ... ...unfiltered ·004; filtered ·002
Organic „ ... ... „ — „ ·002
Oxygen absorbed in 4 hours at 270° C. „ — „ ·007

No nitrites in either.

Crayford. METROPOLITAN WATER BOARD. (In Chalk. See p. 112.)

KENT WATER CO.'S WELL, 200 feet deep, Feb. 8th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 100.
Repeated pp. 275, 293.

Clear and palatable. Temperature 11·4° C.

Total solid impurity	35·2	Parts per 100,000.
Organic carbon	·031	
Organic nitrogen (no ammonia)	·005	
Nitrogen as nitrates and nitrites	·505	
Total combined nitrogen ...	·51	
Chlorine	2·25	

Hardness, temporary 20·3, permanent 5·4; total, 25·7.

By Dr. A. J. BERNAYS, collected October 7th, 1878. *London Water Supply*, by Sir F. BOLTON, 1884, p. 81. Supplemented (first part) from the MSS. Papers of Sir J. PRESTWICH.

Potassoxide ...	·6	[Total 23·51] grains per gallon.
Sodium-oxide ...	·64	
Calcium-oxide ...	9·92	
Magnesia	·47	
Chlorine	1·17	
Carbon-dioxide ...	7·31	
Sulphur-trioxide ...	·9	
Nitrogen-pentoxide	1·27	
Silica	1·23	

Probably combined as follows.

Sodium-chloride ...	1·2	Total 23·24 grains per gallon.
Potassium-sulphate	1·11	
Calcium-chloride...	·68	
Calcium-sulphate...	·66	
Calcium-carbonate	16·62	
Magnesium-nitrate	1·74	
Silica	1·23	

Residue by analysis, 22·96.

Hardness before boiling 17·6, after boiling 2·8.

There are several analyses of the organic matters, etc., by Dr. A. J. BERNAYS, in *London Water Supply*, 1884, p. 82. From two wells.

Crossness, *see* **Erith**, p. 303.

Dartford. Messrs. HALL'S POWDER WORKS.

Made and communicated by Mr. C. BEADLE.

Sample taken from the discharge of the condenser, derived from the large well in the power-house.

Total solids	43·
Lime (CaO)	14·52
Magnesia (MgO)...	·57
Silica (SiO_2)	1·25
Ferric oxide and alumina, trace	—
Chlorine	3·25
Sulphates (SO_3)	4·61

Total hardness (Hehner's method) 28·5, temporary 18, permanent 10·5. Clark's scale, total 26.

The rest-levels average nearly 8 feet above the effective level of the creek.

He thinks that at least 5 *per cent.* of the water pumped is derived from the river.

Deal.

From shallow wells.

1. Pump in Market Place, from well under Town Hall.

2. Public Pump in Fish Market. Both August 28th, 1873. [Old and abandoned wells.—W. W.]

Rivers Pollution Commission. Sixth Report, p. 83. In parts per 100,000.

	1.	2.
Total solid impurity	146·	159·16
Organic carbon	·241	·3
Organic nitrogen	·034	·34
Ammonia	1·7	·34
Nitrogen as nitrates and nitrites	6·345	5·969
Total combined nitrogen ...	7·779	6·589
Chlorine	19·2	28·5

1. Hardness, temporary 33, permanent 34·3 ; total 67·3.
2. „ „ 24, „ 47·1 ; „ 71·1.

1. Clear. 2. Slightly turbid. Both slight saline taste.

We need not be surprised that the Commission speaks of these wells in the following terms (p. 334) :—

"The water from the public pump in the Fish Market consisted chiefly of soakage from sewers or cesspools. The large quantities of ammonia and of chlorine which it contained show that a considerable proportion of urine gains access to it. As is usually the case in such wells, much of the sewage matter was oxidised, but there was still left a marked proportion of actual organic matter of disgusting origin. Although the water was palatable and tolerably clear, its use is very dangerous to the public health, and the well ought to be at once closed. It was much too hard for use in washing, and its manure value was about six-sevenths of that of average London sewage."

"The water from the well in the Market Place was frightfully polluted by sewage. It was entirely unfit for domestic purposes, and the well should be closed in the interests of the public health. It was also too hard for washing. It was well adapted for the irrigation of crops, its manure value being fully equal to that of average London sewage."

3. MR. HILL'S BREWERY, 22nd July, 1869.

Rivers Pollution Commission. Sixth Report, 1874, p. 106.

Given as an example of a polluted water from a deep well in the Chalk.

Total solid impurity	202·14	Parts per 100,000.
Organic carbon	·139	
Organic nitrogen	·137	
Ammonia	·065	
Nitrogen as nitrates and nitrites	1·967	
Total combined nitrogen ...	2·167	
Chlorine	71·82	

Hardness, temporary 31, permanent 16·2 ; total 47·2.

Apparently a case of fairly free communication with the sea as well as of strong pollution by organic matters.

Deptford.

Water from the Chalk.

1. LAMBERT'S BREWERY. 1844. (See p. 117.)

By Prof. T. GRAHAM. *Proc. Inst. C.E.*, 1846, vol. v., p. 204, and *Report on the Supply of Water to the Metropolis.* Appendix ii., p. 94 (and on plate).

Carbonate of lime ...	16·74	Total solid matter 26·2. Grains per gallon.
Carbonate of magnesia	·8	
Sulphate of magnesia ...	2·75	
Sulphate of soda ...	2·67	
Chloride of sodium ...	1·91	
Loss	1·33	

2. NORFOLK BREWERY. 3. BROADWAY.

By H. K. BAMBER, *Trans. Soc. Eng.* for 1867, p. 75.

	2.	3.
Carbonate of lime ...	16·85	16·34
,, ,, magnesia	·563	·6
Sulphate of lime ...	3·332	3·21
Chloride of sodium ...	2·06	2·15
Organic matter ...	2·203	2·3
Alkaline nitrate ...	·632	·675
	25·64	25·275

4. TRUNDLEY'S ROAD. September, 1904. (See p. 119.)

Made and communicated by Dr. J. C. THRESH.
Deposited oxide of iron on standing.
Saline constituents, in parts per 100,000.

Ca. 17·	Mg. 5·3 (? 3·3)	Na.	CO_3. 16·4	SO_4. 13·5	Cl. 23·8	NO_3. ·1	Probable combinations.
10·9	—	—	16·4	—	—	—	Calcium carbonate 27·3
5·65	--	—	—	13·5	—	—	Calcium sulphate... 19·15
·45	—	—	—	—	·8	—	Calcium chloride ... 1·25
—	3·3	—	—	—	9·6	—	Magnesium chloride 12·9
—	—	8·7	—	—	13·4	—	Sodium chloride ... 22·1

Silica, water of hydration, etc. Ferric oxide 4·4

Total solid constituents dried at 180° C. ... 87·1

Free ammonia ·05, organic ammonia ·005.

5. WORKS OF THE METROPOLITAN WATER BOARD. (Wells in Chalk. See p. 118.)

By Dr. A. J. BERNAYS in Sir F. BOLTON'S *London Water Supply*, 1884, p. 81. Supplemented (first part, Bath Well only) from the MSS. Papers of Sir J. PRESTWICH.

Samples taken, from the Bath Well, October 7th, 1878, and from the Garden Well June 26th, 1878. In grains per gallon.

Potassoxide ...	·66	[Total 27·88]
Sodium-oxide ...	1·56	
Calcium-oxide ...	10·91	
Magnesia	·71	
Chlorine	1·66	
Carbon-dioxide ...	8·39	
Sulphur-trioxide ...	1·46	
Nitrogen-pentoxide	1·34	
Silica	1·19	

These are probably combined as in left column of figures below.

	Bath Well.	Garden Well.
Sodium-chloride	2·73	1·5
Sodium-sulphate	·27	—
Potassium-sulphate	1·23	·17
Calcium-chloride	—	·15
Calcium-sulphate	1·26	9·11
Calcium-carbonate	18·55	15·41
Magnesium-nitrate	1·84	2·17
Magnesium - carbonate	·44	4·3
Silica	1·19	1·11
Total	27·51	33·92

Hardness, Bath Well, before boiling 20·3, after boiling 5·4
„ Garden „ „ „ 20·27, „ „ 6·97

Total residue, Bath Well, 26·92 ; Garden Well, 33·12.

Another analysis (May 17th, 1878) from the MSS. Papers of Sir J. **Prestwich.**

	Grains per gallon.
Total solids	31·54
Nitrogen as nitrates, etc.	·465
Nitric anhydride	1·79
Albuminoid ammonia (no free ammonia)	·002
Organic carbon	·02
Organic nitrogen	·007
Chlorine (as sodium-chloride 2·94)	1·78

Hardness before boiling 20·09, after boiling 6·04.

Constituents.

	Grains per gallon.
Sodium-oxide	1·48
Potassoxide	·29
Lime	12·46
Magnesia	1·36

A great number of analyses of the organic matters, etc. (other than full mineral analyses) of the waters of the Deptford Waterworks Wells are to be found in Sir F. **Bolton**'s *London Water Supply*, 1884, pp. 82, 83, by Dr. **Bernays**, as well as of the water supplied at the Deptford Bridge Police Station, pp. 84, 85 ; but none of the analyses are given in the second edition of that book.

There are also similar analyses in the *Sixth Report of the Rivers Pollution Commission*, 1874, p. 100. Repeated pp. 275, 293.

New Well. February 8th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 100. Repeated pp. 275, 293.

Clear and palatable. Temperature 12·2° C.

	Parts per 100,000.
Total solid impurity	42·94
Organic carbon	·048
Organic nitrogen	·005
Ammonia	·001
Nitrogen as nitrates and nitrites	·545
Total combined nitrogen	·551
Chlorine	2·5

Hardness, temporary 20·1, permanent 9·6 ; total 29·7.

6. Mazawattee Tea Co. April, 1903.

[I am in doubt whether the well here is in Kent or Surrey ; but one may fairly enter this analysis here.—W. W.]

Information from the Company, communicated by Mr. C. **Beadle.**

In grains per gallon.

Total solids...	139·
Lime (CaO)...	22·79
Magnesia (MgO)	6·31
Sulphuric acid (SO_3) ...	14·95
Chlorine	54·8
Nitric acid (N_2O_5)... ...	·35
Silica	·9
Oxide of iron, alumina, etc.	·45

Alkalinity 23·3°. Hardness 53° on Wanklyn's scale.

Dover.

PUBLIC SUPPLY. (From the Chalk. See p. 122.)

1. By Dr. LETHEBY. About 1867? *S.E. Naturalist*, 1894, vol. i., pt. iv., p. 109.

Carbonates of lime and magnesia	13·75	Grains per gallon.
Sulphates " " " "	2·42	
Sodium chloride	·92	
Sodium nitrate	4·25	
Silica and alumina	·67	
Organic matter, none	—	
Total solids ...	22·01	

Hardness before boiling 17°, after boiling 6½°.

The following additional particulars from Royal Commission on Water Supply. Appendix, p. 77. Fol. *Lond.* 1869.

Bright and nearly colourless, in glass tube 2 feet long.

Organic and other volatile matter	1·04	Grains per gallon.
Oxygen required to oxydise organic and other matter	·005	
Ammonia	·001	

For an analysis in 1873 see further on.

2. By G. W. WIGNER. *The Water Supply of Sea-side Watering-places*, 1878, p. 37. Reproduced in *S.E. Naturalist*, 1894, vol. i., pt. iv., p. 110. Sample drawn from the mains. Results in grains per gallon.

Total solid matter	22·9
Loss on ignition after deducting combined carbonic acid	3·08
Chlorine calculated as chloride of sodium	2·81
Nitrogen as ammonia	·0018
" " albuminoid ammonia	·0024
" " nitrates	·139
" " nitrites	·001
Total nitrogen in these four forms...	·1442
Oxygen absorbed by organic matter	·011

Hardness, Clark's scale, before boiling 15°, after boiling 3°.

Microscopic examination quite satisfactory. Water free from objectionable smell or taste. Good pale blue and free from suspended matter. A first-class water.

3. By Dr. GLAISTER. 1893. Reduced to grains per gallon. *S.E. Naturalist*, 1894, vol. i., pt. iv., p. 110.

Previous sewage or animal contamination	2·95
Chloride of sodium	3·
Organic carbon	·024
Organic nitrogen	·006
Ammonia	·0007
Nitrogen as nitrates and nitrites ...	3·164
Total nitrogen	3·231
Total solid impurity	20·72

Hardness before boiling 16·52°, after boiling 3·5°.

4. Made and communicated by Dr. J. C. **Thresh**. March, 1899. Great part published in his *Examination of Waters*, 1904.

Saline constituents, in parts per 100,000.

Ca. 9·7	Mg. ·2	Na.	CO$_3$. 12·3	SO$_4$. ·8	Cl. 2·4	NO$_3$. 2·	Probable combinations.
8·2	—	—	12·3	—	—	—	Calcium carbonate 20·5
·35	—	—	—	·8	—	—	Calcium sulphate... 1·15
·65	—	—	—	—	—	2·	Calcium nitrate ... 2·65
·5	—	—	—	—	·9	—	Calcium chloride... 1·4
—	·2	—	—	—	·6	—	Magnesium chloride ·8
—	—	·6	—	—	·9	—	Sodium chloride ... 1·5
							Silica, etc.... ... 2·5

Total solid constituents dried at 180° C. 30·5

Organic ammonia (no free ammonia) ... ·001
Oxygen absorbed in 4 hours at 27° C. ·032

Another analysis. From a well half a mile S.W. of the citadel. Also in Chalk. Ground-level 87 feet above Ordnance Datum. Water-level 65 feet down. Also March, 1899.

Saline constituents, in parts per 100,000.

Ca. 9·6	Mg. ·3	Na.	CO$_3$. 11·4	SO$_4$. 1·3	Cl. 4·85	NO$_3$. 3·7	Probable combinations.
7·6	—	—	11·4	—	—	—	Calcium carbonate 19·
·55	—	—	—	1·3	—	—	Calcium sulphate... 1·85
1·2	—	—	—	—	—	3·7	Calcium nitrate ... 4·9
·25	—	—	—	—	·45	—	Calcium chloride... ·7
—	·3	—	—	—	·9	—	Magnesium chloride 1·2
—	—	2·3	—	—	3·5	—	Sodium chloride ... 5·8
							Silica, etc.... ... 2·05

Total solid constituents dried at 180° C. 35·5

Organic ammonia (no free ammonia) ... ·001
Oxygen absorbed in 4 hours at 27° C. ·029

5. Waterworks well, 220 feet deep. 6. Well in Castle, 367 feet deep. (included here for convenience.) Both March 1st, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 99. In parts per 100,000.

In both, water clear and palatable. In 5, temperature 11·3 C. In 6, 13°.

	5.	6.
Total solid impurity	29·6	35·56
Organic carbon	·034	·028
Organic nitrogen...	·008	·005
Ammonia	·001	·001
Nitrogen as nitrates and nitrites	·452	·773
Total combined nitrogen ...	·461	·779
Chlorine	2·6	4·

5. Hardness, temporary 18·6, permanent 5 ; total 23·6.
6. „ „ 18·3, „ 5 ; „ 23·3.

7. By Mr. S. Harvey. From sample taken July, 1907.

Chlorine in chlorides	1·61
Nitrogen in nitrates	·38
Albuminoid ammonia (no free)	·0014
Oxygen absorbed in 15 minutes, trace only	—
„ „ „ 4 hours	·014
Total solid matter	22·47

Clear, green-blue, no smell.
Hardness before boiling 18·8°, after boiling 3·3°.
Microscopical examination of deposit. Slight and unimportant.

Mr. H. E. Stilgoe remarks on this that the hardness and total solid matter are higher than usual, probably owing to the water coming from new adits, and that the figures will decrease.

Downe. Well at High Elms, 150 feet deep, October 30th, 1870.

Rivers Pollution Commission. Sixth Report, 1874, p. 100. Repeated p. 293.

Water clear and palatable. From Chalk.

Total solid impurity	30·48	Parts per 100,000.
Organic carbon	·041	
Organic nitrogen (no ammonia)...	·026	
Nitrogen as nitrates and nitrites	·44	
Total combined nitrogen ...	·466	
Chlorine	1·18	

Hardness, temporary 21·3, permanent 3·5; total 24·8.

East Langdon. East Kent Waterworks. (From Chalk. See p. 123.)

Communicated by Mr. F. L. Ball.

By Dr. G. H. Ogston, November 1897.

Total solid matter	23·8	Grains per gallon.
Chlorine	1·6	
Sulphuric acid...	·14	
Nitric acid	1·35	
Lime	8·23	
Magnesia	·51	
Oxygen required to oxydise organic matter	·008	
Ammonia, free, trace; albuminoid... ...	·006	

Hardness, total 15°, permanent 4·5°.
Appearance in 2-foot tube, clear and bright.
A chalk-water of exceptional purity, containing only the faintest indication of the presence of organic matter. An excellent water in every way and entirely free from pollution.

Another analysis, of September, 1906, by Mr. C. H. Cribb.

Albuminoid ammonia (no free ammonia)	·0006	Parts per 100,000.
Oxygen absorbed in 15 minutes ...	·022	
„ „ „ 4 hours	·022	
Total solid residue	35·76	
Chlorine	2·9	
Nitrogen as nitrates and nitrites ...	·58	

Temporary hardness 25·7, permanent 5.
The sample was clear and palatable.

Another analysis. From the Water Works Directory 1907.

Ammonia, free (no albuminoid) ...	·0005	Parts per 100,000.
Oxygen absorbed in 15 minutes ...	·011	
„ „ „ 4 hours ...	·022	
Total solid residue	33·2	
Chlorine...	2·6	
Nitrogen as nitrates and nitrites ...	·503	

Hardness 23·6; temporary 18; permanent 5·6.
Clear and palatable.

Erith.

1. Callender Cable and Construction Company. On the Marshes above the town.

Communicated by Mr. C. **Beadle**. Information from Mr. **Callender**.

Some of the wells are deep, others shallow; but the composition of the water does not vary.

Calcium carbonate ...	19·48	Total 49·44 grains per gallon.
Magnesium carbonate	1·05	
Magnesium sulphate...	5·88	
Sodium sulphate ...	1·44	
Sodium chloride ...	21·59	

2. Well belonging to the Kent Co. at Belvedere, 70 feet deep, February 11th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 100. Repeated pp. 275, 293.

Water clear and palatable. Temperature 11·58 C. Condemned as "of objectionable quality," p. 285.

Total solid impurity	40·52	Parts per 100,000.
Organic carbon	·1	
Organic nitrogen (no ammonia)...	·037	
Nitrogen as nitrates and nitrites	2·079	
Total combined nitrogen ...	2·116	
Chlorine	3·35	

Hardness, temporary 10·8, permanent 11·6 ; total 22·4.
This small pumping-station has been disused for a long time.

3. Crossness. (See p. 127.)

Made by Mr. M. A. **Adams**, October 1894. Communicated by Dr. **Clowes**. In grains per gallon, except for ammonia.

*Total solids...	52·	
†Loss on ignition	7·2	
†Chlorine	11·8	
Nitrogen as nitrates	·3	
†Free ammonia (no albuminoid ammonia)	·21	(parts per million).
*Oxygen absorbed in ¼ hour	·021	
„ „ 4 hours	·031	

Phosphoric acid, slight trace.

* Excess. † Large excess.

Hardness, total 9·3°, permanent 8·4°.
Appearance in 2-foot tube, greenish-yellow, turbid.
"I regard the wholesomeness of this water with great suspicion."

4. Thames Steam Saw Mills. February, 1903.

Information from the Company, communicated by Mr. C. **Beadle**.

Sodium chloride ...	7·35	Total 40·67 grains per gallon.
Sodium nitrate ...	6·9	
Magnesium sulphate	2·41	
Calcium sulphate ...	3·99	
Calcium carbonate...	18·9	
Silica	1·12	

Eynsford.

1. Lower Austin Lodge, about a mile southward of the Church. Well 78 feet deep [in Chalk]. Water 156 feet above Ordnance Datum.

By Dr A. J. Bernays, collected October 7th, 1878. From MSS. Papers of Sir J. Prestwich. In grains per gallon.

Potass-oxide ...	·22
Sodium-oxide ...	·67
Calcium-oxide ...	8·32
Magnesia	·38
Chlorine	·89
Carbon-dioxide ...	5·51
Sulphur-trioxide ...	1·92
Nitrogen-pentoxide	1·02
Silica	·7

[Total 19·63].

These are probably combined as follows :—

Sodium-chloride ...	1·26
Potassium-sulphate	·41
Calcium - sulphate	2·94
Calcium-chloride...	·2
Calcium-carbonate	12·52
Magnesium-nitrate	1·4
Silica	·7

Total 19·43.

Total residue 19·24.

Hardness before boiling 15·7, after boiling 3·15.

Nitrogen (oxydised), no ammonia, ·264.

A sample taken on March 2nd, 1878, gave the following results, which may be compared with those of the analysis of the water from the well at the Railway Station, taken on the same day. Both are on the same authority as the above :—

	1. Lower Austin Lodge.		2. Railway Station.	
	Grains per gallon.	Parts per 100,000.	Grains per gallon.	Parts per 100,000.
Total solid matter	19·46	27·8	19·66	28·8
Chlorine	.55	·79	·93	1·33
Ammonia, free	·0014	·002	none	—
Ammonia, albuminoid	·0031	·0044	·0008	.0012
Organic carbon	·024	·034	·022	·031
Organic nitrogen	·008	·012	·007	·01
Nitrogen as nitrates and nitrites	·257	·367	·253	·361

1. Hardness 15·44, permanent 3·26.
2. „ 16·27, „ 3·91.

Faversham. Well, 74 feet deep.

By W. W. Fisher. *The Analyst*, August, 1901.

Classed with waters from Chalk below the London Clay, which must be an error, as in this neighbourhood the base of the London Clay is separated from the top of the Chalk by a good deal more than 74 feet of other deposits.

Total solids	40·
Chlorine in chlorides... ...	4·9
Nitrogen in nitrates	·05
Ammonia	·006
Albuminoid ammonia... ...	·004
Oxygen absorbed in 3 hours	·015

Grains per gallon.

Hardness, 29·2.

Folkestone.

1. HOTEL METROPOLE (Western Cliff). Trial-boring (see p. 136.)

Supply from Lower Greensand.

By R. H. HARLAND, 1896.

Physical Characteristics.

Colour, examined in a tube 2 feet long, yellowish, opaque.
Suspended matter, heavy, consisting of mineral matter.
Smell, when heated to 100° F., none.
Hardness before boiling 15°, after boiling 5°.

Chemical Results, in grains per gallon.

Total solid matter	30·1
Loss on ignition, after deducting combined carbonic acid	3·5
Total mineral matter	26·6
Chlorine, equal to chloride of sodium	7·
Nitrogen as ammonia	·0087
Nitrogen as albuminoid ammonia	·0056
Nitrogen as nitrates	·179
Oxygen absorbed by organic matter from solution of permanganate of potash, at 80°F. in 2 minutes	·0056
Ditto in 4 hours	·0680

A very good sample of water, free from pollution with sewage and drainage-matter. A satisfactory supply for drinking and domestic purposes.

Another analysis, made and communicated by Mr. C. EKIN, is as follows:—

Total solids	236·	Parts per million.
Chlorine	30·	
Ammonia	·06	
Nitrogen as nitrates (no nitrites)	1·98	

2. WATERWORKS. (See p. 138.)

Rivers Pollution Commission. Sixth Report, 1874, p. 97. Repeated p. 343. In parts per 100,000.

Four analyses, all August 9th, 1873. The fourth (from p. 343) is for the combined supply (of all four wells, besides the Cherry Garden Spring, for analysis of the water of which see p. 277) as it left the lower reservoir, Cherry Gardens. The wells get their supply from Lower Greensand.

Temperature of first two 11·5° C., of third 11·3°.

	Well No. 2, 39 feet.	Well No. 3, 43 feet.	Well No. 4, 41 feet.	Supply.
Total solid impurity	48·96	41·14	40·5	37·78
Organic carbon	·107	·091	·12	·186
Organic nitrogen	·021	·021	·016	·041
Ammonia	—	·004	·013	·005
Nitrogen as nitrates and nitrites	none	none	none	·023
Total combined nitrogen	·021	·024	·027	·068
Chlorine	5·6	4·2	4·2	4·3
Hardness, temporary	23·7	24·6	22·9	19·3
„ permanent	10·4	7·	8·1	7·6
„ total	34·1	31·6	31·	26·9

All three clear and palatable.

On p. 343 we are told that "as wells Nos. 2, 3. and 4 delivered into well No. 1, no separate sample of the water yielded by the latter could be obtained."

On p. 344 of the Report the following remarks occur:—"By storage in the open reservoirs the water becomes slightly softer, but at the same time contracts a marked amount of organic impurity . . . taking . . the average composition of the affluent waters and comparing it with the composition of the effluent water from the reservoir, the proportion of organic matter in the effluent is double that present in the affluent water. Nevertheless, the original purity of the water is so great that, even after this deterioration in the reservoirs, it must be pronounced to be on both occasions when we examined it of fairly good quality."

"There were not wanting visible causes sufficient to account for the deterioration of the water during its sojourn in the storage reservoirs. There are two houses and some cow sheds situated near to and above the storage reservoirs, and the so-called 'Cherry Gardens' near these houses, are . . to some extent a place of public resort, and there is no sufficient fence around the springs and reservoirs to prevent trespassers from gaining access to the water . . we noticed that ducks were kept upon the reservoirs, and that sheep were admitted to pasture upon the grassy banks sloping down to the water's edge. Hard water from springs and wells is very prolific of confervoid growths, and such growths were noticed in the reservoirs." The Commissioners recommended softening and storage in covered reservoirs.

By G. W. Wigner, *The Water Supply of Sea-side Watering-places*, 1878, p. 38.

Sample drawn from a main-tap. Results in grains per gallon.

Total solid matter	24·4
Loss on ignition after deducting combined carbonic acid	5·34
Chlorine calculated as chloride of sodium	4·21
Nitrogen as ammonia	·0023
,, ,, albumenoid ammonia	·005
,, ,, nitrates	·039
,, ,, nitrites	·003
Total nitrogen in these four forms	·0493
Oxygen absorbed by organic matter	·0176

Hardness, Clark's scale, before boiling 13·4°, after boiling 4°.

"The water contained traces of suspended matter, which rendered it slightly turbid, otherwise the colour seemed good. The smell even when heated was good, but a slightly chalky taste was perceptible." Microscopic results quite satisfactory. A good water, but would be improved by filtration.

From tap of main, 15 Castle Hill Avenue. The mixed water, from various sources, as supplied.

(*a*) By Mr. S. Harvey, June, 1904. From the Report of the Medical Officer of Health for 1904. Communicated by Dr. F. Parsons. (*b*) The second column of figures, by the same analyst, from the supply-main, 1895. In grains per gallon? Appearance clear. Colour green-blue. No smell.

	a.	*b.*
Chlorine in chlorides	1·89	2·38
Nitrogen in nitrates	·28	·15
Ammonia	—	·0004
Albumenoid ammonia	·0011	·0025
Oxygen absorbed in 15 minutes	trace only	trace only
,, ,, 4 hours...	·036	·068
Total solid matter	23·11	28·77

(*a*).

Hardness before boiling 17·6°, after boiling (permanent) 2·7°.

Microscopical examination of deposit:—Very slight and unimportant.

The above results are satisfactory throughout and indicate water organically pure and free from sewage-percolation. The microscopical examination calls for no adverse remarks.

Bacteriologic Examination.

Quite satisfactory. After three days' incubation 42 micro-organisms per cubic centimeter were obtained (the average of several closely agreeing estimations), of which more than 90 per cent. were minute and developed but slightly. The colonies from the above micro-organisms varied but little in character, and were such as are ordinarily observed in the purest water. They ought not to be regarded with the least suspicion. Careful search was made for pathogenic organisms, with negative results.

b.

Hardness before boiling 22·6°, after boiling (permanent) 5·2°.

Microscopical examination of deposit:—Slight organic débris.

The results satisfactory throughout, especially as regards the figures for organic impregnation, which are low.

Analysis of the Lower Greensand water, from No. 5 well. (Water Works Directory 1907.)

Chlorine in chlorides...	2·52	
Nitrogen in nitrates	·12	Grains per gallon.
Ammonia	·0031	
Albuminoid ammonia	·0028	
Oxygen absorbed in 15 minutes	trace only	
„ „ „ 4 hours ...	·042	
Total solid matter	32·76	

Hardness, before boiling 23·1°, after boiling 5·4°.

Clear, green-blue, no smell. The above results very satisfactory and indicate water of great organic purity.

Frindsbury.

1. Chattenden Barracks. (See p. 140.)

Water from the Lower Greensand.

Made and communicated by Dr. A. M. Davies, Assistant Professor of Hygiene, Netley. Drawn December, 1887.

Colourless, clear, some sediment, good lustre, no taste (?), and no smell.

Hardness (in parts per 100,000), fixed 1·5, removable 3·5; total 5.

Qualitative Examination (for some things see Quantitative).

Lime, faint trace.
Magnesia, present.
Phosphoric acid, trace.
Nitric acid, doubtful.
Metals, none, or a mere trace of iron.

Quantitative Examination. Parts per 100,000.

Volatile matter	16·
Chlorine	45·
Calcium carbonate	2·3333
Fixed hard salts	1·5
Sulphuric acid (SO_4)	7·1667
Alkaline carbonates	
Sodium or other metal, combined with Cl or SO_4, not included in fixed hard salts	
Silica, alumina, iron, etc.	
Total solids by evaporation... ...	72·

Oxygen required for organic matter		·048
These, with the oxidisable organic matter, are included in the volatile matter (above)	Free ammonia	·056
	Albumenoid ammonia and nitrous acid, none	—
	Nitric acid (NO_3), doubtful	·1108
	Total nitrogen, included in nitrites and nitrates	·025

The chlorine is in very large excess, also the free ammonia; but as the well is of great depth the water is not to be rejected on that account. It is very pure in other respects. Dr. Davies writes that he thinks the volatile matter is too high, and that some chlorides may have been driven off.

Microscopic Examination.

The sediment consists of amorphous matter, with some decaying vegetable matter, a few infusoria and a little sand.

2. Whitewall Cement Works. (See p. 142.)

Water from the Lower Greensand.

By Dr. A. Voelcker, June, 1882. In grains per gallon.

Communicated by Mr. J. H. Wood, of Formby's Cement Works Co.

Oxidisable organic matter	·67
Oxide of iron and alumina	·56
Lime	1·56
Magnesia	·8
Sulphuric acid	1·96
Chlorine	29·88
Soluble silica	·56
Alkalies and carbonic acid, not determined separately	—
Actual (saline) ammonia	·07
Organic (albumenoid) ammonia	·021

The composition may be represented as follows:—

Oxidisable organic matter	·67
Oxide of iron and alumina	·56
Carbonate of lime	·34
Sulphate of lime	3·33
Carbonate of magnesia	1·68
Chloride of sodium	49·23
Alkaline carbonates	20·91
Soluble silica	·56
Total solid constituents dried at 130° C.	77·28

The water is clear, colourless and free from smell; has a strongly alkaline reaction and contains much carbonate of soda, and is singularly free from organic impurity.

Goudhurst. Cranbrook District Waterworks. From the Company's "Rules and Regulations." Water from the Ashdown Beds.

By Dr. O. Hehner. Two analyses, in parts per 100,000.

	Inside bore.	Outside bore.
Chlorine	3·15	3·3
Sulphuric acid	5·64	5·84
Nitric acid	·16	·18
Free ammonia	·0078	·0083
Albuminoid ammonia	·0038	·006
Oxygen absorbed from permanganate in 15 minutes, at 80° F.	·0144	·0184
Oxygen absorbed from permanganate in 4 hours, at 80° F.	·0304	·0336
Total solids	23·72	23·92
Loss on ignition	1·41	1·68
Hardness	18	18
Colour in two-foot tube	turbid	faint yellow

"The two samples are almost identical in composition. Both organically and as regards mineral constituents, no fault can be found. . . The slight turbidity . . will no doubt disappear in time . . both samples are perfectly fit for drinking, and for all general domestic purposes."

? Later analysis, by Dr. J. S. Tew, July 1906, in parts per 100,000.

Communicated by Mr. C. D. Murton.

Ammonia free	faint trace
„ albuminoid	·002
Oxygen absorbed in 2 hours at 80° F.	·005
Total solids	20
Loss on ignition	9
Hardness total	9
„ permanent	6
Chlorine	3·4
Nitrogen as nitrites	nil
„ „ nitrates	trace
Iron	strong trace

Physical characters. Clear and bright; no smell on warming.
Of high organic purity; suitable for drinking and domestic purposes.

A bacteriologic examination by Dr. J. S. Tew, April 1906.

Average number of organisms [? per cubic centimetre] capable of development on nutritive gelatine after incubation for 63 hours at 20° to 22° C. was 19.

Proportion of liquefying organisms was 1 to 4.

12 cubic centimetres distributed on four Agar plates gave no growths after 72 hours incubation at 37° C.

5 cubic centimetres incubated for 24 to 48 hours at 37° C. in 10 c.c. of Broth with 1 c.c. of Parietti's fluid, gave no growths. No gas-forming organisms present.

Bacteriologically very satisfactory, shewing no sign of animal or vegetable contamination.

Gravesend.

All these waters are from the Chalk.

1. Close to Milton Church.

Made and communicated by Dr. J. C. Thresh. June, 1899.

Saline constituents, in parts per 100,000.

Ca. 10·75	Mg. ·35	Na.	CO_3. 15·	SO_4. 1·75	Cl. 2·5	NO_3. 3·7	Probable combinations.	
10·	—	—	15·	—	—	—	Calcium carbonate	25·
·75	—	—	—	1·75	—	—	Calcium sulphate...	2·5
—	·35	—	—	—	1·	—	Magnesium chloride	1·35
—	—	1·	—	—	1·5	—	Sodium chloride ...	2·5
—	—	1·35	—	—	—	3·7	Sodium nitrate ...	5·05
							Silica, etc.... ...	1·6

Total solid constituents dried at 180° C. 38·

Organic ammonia (no free ammonia)... ·006
Oxygen absorbed in 4 hours at 27° C. ·042

2. Prince of Wales Inn.

Made and communicated by Dr. J. C. Thresh.
Well 35 feet deep, in Chalk.
Saline constituents, in parts per 100,000.

Ca. 12·	Mg. ·6	Na.	CO_3. 15·	SO_4. 1·8	Cl. 2·6	NO_3. 5·75	Probable combinations.
10·	—	—	15·	—	—	—	Calcium carbonate 25·
·75	—	—	—	1·8	—	—	Calcium sulphate... 2·55
1·25	—	—	—	—	2·2	—	Calcium chloride... 3·45
—	·15	—	—	—	·4	—	Magnesium chloride ·55
—	·45	—	—	—	—	2·3	Magnesium nitrate 2·75
—	—	1·3	—	—	—	3·45	Sodium nitrate ... 4·75
							Silica, etc.... ... ·65

Total solid constituents dried at 180° C. 39·7

Free ammonia ... ... ·006
Organic ammonia... ... ... ·003
Oxygen absorbed in 4 hours at 27° C. ... ·018

3. Railway Station. January 17th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 106.

Given as an example of polluted water from a deep well (70 feet) in Chalk.

Clear and palatable. Temperature 10° C.

Total solid impurity	68·	Parts per 100,000.
Organic carbon	·127	
Organic nitrogen	·029	
Ammonia	·076	
Nitrogen as nitrates and nitrites	2·937	
Total combined nitrogen ...	3·029	
Chlorine	5·4	

Hardness, temporary 27·9, permanent 14·5; total 42·4.

4. Waterworks. (See p. 145.)

Waterworks' well, 200 feet deep, January 17th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 100.

Clear and palatable. Temperature 9·7° C.

Total solid impurity	36·52	Parts per 100,000.
Organic carbon	·03	
Organic nitrogen (no ammonia)...	·009	
Nitrogen as nitrates and nitrites	·582	
Total combined nitrogen... ...	·591	
Chlorine	2·4	

Hardness, temporary 20, permanent, 7·9; total 27·9.

By A. Dupré, September, 1893. (In grains per gallon.)
Communicated by Dr. F. Parsons.

Water clear, almost colourless, free from smell and yielded no deposit. It shows no sign of pollution by sewage or surface-drainage and is remarkably free from organic impurity. In this respect it fully maintains the high character which it has held for years. It would be improved for general domestic purposes by being softened.

Hardness before boiling 20°, after boiling 4·2°.

Phosphoric acid, very minute trace	·014
Oxygen absorbed from permanganate	
Total dry residue (white). Clears very slightly on ignition and burns off readily	30·08
Chlorine	1·61
Nitric acid (no nitrous acid)	2·38
Albumenoid ammonia (no free ammonia)	·0022

A later and fuller analysis of the water of the Public Supply of Gravesend, made and communicated by Dr. J. C. THRESH, is as follows:—

Saline constituents, in parts per 100,000.

Ca. 11·4	Mg. ·25	Na.	CO_3. 15·15	SO_4. ·55	Cl. 2·4	NO_3. 4·	Probable combinations.	
10·1	--	—	15·15	—	—	—	Calcium carbonate	25·25
·25	—	—	—	·55	—	—	Calcium sulphate...	·8
1·05	—	—	—	—	—	3·25	Calcium nitrate ...	4·3
—	·25	—	—	—	—	·75	Magnesium nitrate	1·
—	—	1·55	—	—	2·4	—	Sodium chloride ...	3·95
							Silica, etc.... ...	1·7

Total solid constituents dried at 180° C. 37·

Free ammonia	·001
Organic ammonia	·006
Oxygen absorbed in 4 hours at 27° C.	·027

GRAVESEND SANITARY LAUNDRY.

Letter from F. A. SPAIN, Secretary, to Mr. C. Beadle. 1904.

The Company had a well, 35 feet deep, from which some 30,000 gallons a week were pumped for 3½ years, the water being pure and not brackish. Two years ago the well gave out. The Company then sank to the depth of 175 feet, when a copious supply was got, but the water was so brackish that it could not be used. By some nine months' steady pumping the salt has been reduced to a very large extent, and the water is apparently very pure.

Greenhithe.

1. Well about 170 feet deep in Chalk.

Made and communicated by Dr. J. C. THRESH, March, 1900.
Saline constituents, in parts per 100,000.

Ca. 10·	Mg. ·25	Na.	CO_3. 15·6	SO_4. 1·3	Cl. 6·6	NO_3. 1·45	Probable combinations.	
10·	—	—	15·	—	—	—	Calcium carbonate	25·
—	·25	—	·6	—	—	—	Magnesium carbonate	·85
—	—	·6	—	1·3	—	—	Sodium sulphate ...	1·9
—	—	4·3	—	—	6·6	—	Sodium chloride ...	10·9
—	—	·55	—	—	—	1·45	Sodium nitrate ...	2·
							Silica, etc.... ...	·35

Total solid constituents dried at 180° C. 41·

Free ammonia	·006
Organic ammonia	·014
Oxygen absorbed in 4 hours at 27° C.	·065

2. THE CHANTRY. March, 1900. Well in High Street, about 20 feet deep.

Made and communicated by Dr. J. C. THRESH.
Saline constituents, in parts per 100,000.

Ca. 11·25	Mg. 1·1	Na.	CO$_3$. 14·8	SO$_4$. 2·2	Cl. 3·	NO$_3$. 4·75	Probable combinations.	
9·9	—	—	14·8	—	—	—	Calcium carbonate	24·7
·9	—	—	—	2·2	—	—	Calcium sulphate...	3·1
·45	—	—	—	—	·8	—	Calcium chloride...	1·25
—	·75	—	—	—	2·2	—	Magnesium chloride	2·95
—	·35	—	—	—	—	1·8	Magnesium nitrate	2·15
—	—	1·1	—	—	—	2·95	Sodium nitrate ...	4·05
							Silica, etc.... ...	1·2

Total solid constituents dried at 180° C. 39·4

Free ammonia	·004
Organic ammonia	·012
Oxygen absorbed in 4 hours at 27° C.	·037

Greenwich.

These waters are from the Chalk.

1. BREWERY. Messrs. Lovibond's, who communicated the particulars in 1868. (See p. 147.)

Lime	15·876	Grains per gallon.
Magnesia ...	1·96	
Soda	3·689	
Sulphuric acid	9·8	
Chlorine ...	2·733	
Carbonic acid	10·164	
Total solids ...	44·222	

a. THE HOSPITAL, now the Royal Naval College. (See p. 147.)

b. PAGE'S BREWERY. 1844. (See page 146.)

By Prof. T. GRAHAM, in grains per gallon, *Proc. Inst. C.E.*, 1846, vol. v., pp. 203, 204, and *Report on the Supply of Water to the Metropolis*, Appendix ii., pp. 24, 25 (and on plate). 8° *Lond.* 1850.

	a.	*b*.
Carbonate of lime ...	19·08	21·23
Carbonate of iron ...	·52	—
Sulphate of magnesia	2·04	2·88
Sulphate of soda ...	3·62	·6
Chloride of sodium ...	·37	3·12
Loss	1·67	—
Total solid matter ...	27·3	27·83

2. North Greenwich. November, 1902. (See p. 149.)

Made and communicated by Dr. J. C. Thresh. Saline constituents in parts per 100,000.

Ca. 32·7	Mg. 3·25	Na.	CO_3. 14·9	SO_4. 13·8	Cl. 133·	NO_3. 1·	Probable combinations.
9·9	—	—	14·9	—	—	—	Calcium carbonate 24·8
5·75	—	—	—	13·8	—	—	Calcium sulphate... 19·55
17·05	—	—	—	—	30·2	—	Calcium chloride... 47·25
—	3·25	—	—	—	9·6	—	Magnesium chloride 12·85
—	—	60·6	—	—	93·2	—	Sodium chloride ...153·8
							Silica, nitrates, etc. ·75

Total solid constituents dried at 180° C....259·

Free ammonia	·088
Organic ammonia	·007
Oxygen absorbed in 4 hours at 27° C.	·016

Note the excessive quantity of calcium chloride.

3. Page's Brewery.

By H. K. Bamber. *Trans. Soc. Eng.* for 1867, p. 75. ? In grains per gallon.

Carbonate of lime ...	14·926
„ „ magnesia	·532
Sulphate of lime ...	4·852
Chloride of sodium ...	3·323
Organic matter ...	2·1
Alkaline nitrate ...	·68
	26·413

Hadlow.

Analyses of water from the Well (boring) at Style Place Brewery. (See p. 150.) The water comes from the Hastings Beds.

By Dr. W. S. Saunders, December, 1891.

The water issued from the tube at a temperature of 59° F. It was bright, colourless, and had a soft, saline and somewhat flat taste.

	Parts per 100,000.	Grains per gallon.
Chlorine	14·5	10·15
Sulphuric acid (SO_3)	·52	·364
Nitric acid (N_2O_5)...	·13	·091
Carbonic acid (CO_2)	27·69	19·383
Silica	·73	·511
Lime...	·49	·343
Magnesia	·11	·077
Sodium	9·39	6·573
Soda	38·82	27·174
Oxide of iron ...	·11	·077
	92·49	64·743

The sodium is put in separately from the soda because the chlorine combines with the metal and not with the oxide.

The preceding substances occur in the form of the following combinations:—

Sodium chloride ...	23·89	16·723
„ sulphate ...	·92	·644
„ nitrate ...	·21	·147
„ carbonate ...	65·55	45·885
Calcium carbonate ...	·85	·595
Magnesium carbonate	·23	·161

Silica and oxide of iron as above.

The water is practically free from organic pollution, thus the Albumenoid (or Organic) Ammonia exists only to the extent of ·02 parts per million, or to ·0014 grains per gallon. The Free (or Saline) Ammonia amounts to ·56 parts per million, or to ·0392 grains per gallon.

This quantity of free ammonia is peculiar to deep waters from the Greensand [this water is *not* from Greensand—W. W.] and is of no consequence in the absence of organic pollution.

The soap-destroying power of the water is only 2½°, by Clark's scale. The water is, therefore, economical for washing and excellent for boilers. Strictly speaking it is a mineral water, being full of mineral salts in solution, which render it highly alkaline. It is remarkable from the circumstance that sulphuric acid, nitric acid, lime and magnesia are almost absent, and that the mineral constituents consist almost exclusively of sodium carbonate and sodium chloride.

Owing to its highly alkaline nature it is undesirable for drinking water, although it is of exceeding organic purity.

[Letter]. It is unsuitable for the ordinary wants of a resident community.

Another Analysis of the same. By Mr. M. A. Adams, October, 1891.

It is altogether a very remarkable water. The amount of the saline constituents is very high, 68·299 grains per gallon; but the most remarkable fact is that no less than 67·037 grains of these consist of salts of sodium and potassium, and 43·347 in the form of sodium carbonate. On the other hand there is almost an absence of the alkaline earths of lime and magnesia and an absolute freedom from iron. This composition is so peculiar that I am unable to find any other water of anything like a similar composition, which makes it therefore a matter for serious consideration, and in no little degree for speculation, as to how the habitual use of such a water would affect the users.

For all detergent purposes, that is to say for personal ablution or the washing of textile fabrics with a minimum expenditure of soap, it is peculiarly well adapted, and in certain skin disorders I have no doubt would be most valuable. For the production of steam it would also answer perfectly, and would cause no fouling of boilers. And for some technical arts it would likewise prove a most excellent water.

As regards its probable effect upon the health of persons consuming it . . . I am disposed to think that it would be unpalatable and somewhat depressing to persons in ordinary health; but, on the other hand, advantageous to persons of gouty or rheumatic tendency, and it would be likely to act beneficially in certain forms of dyspepsia, disorders of the urinary organs, and especially in calculous complaints.

	Grains per gallon.
Potassium ...	9·972
Sodium ...	·995
Soda	26·128
Lime	·266
Magnesia ...	·095
Alumina ...	·07
Silica... ...	·518
Chlorine ...	10·6
Nitric acid ...	1·349
Carbonic acid	18·306
Sulphuric acid	none
	68·299

Probable combinations.

Potassium chloride ...	19·039
Sodium chloride ...	2·529
„ nitrate ...	2·123
„ carbonate ...	43·347
Calcium carbonate ...	·475
Magnesium carbonate	·199

Alumina and silica as before.

Another Analysis of the same. By Dr. G. H. OGSTON, February 25th, 1890.
Total solid matter, 65·73, containing:—

Carbonate of soda	46·4	Grains per gallon.
Chloride of sodium ...	16·72	
Chloride of calcium ...	·71	
Chloride of magnesium	·04	

Ammonia, per million parts, free ·015. organic ·05. No nitrogen as nitrates.

Oxygen required to oxidize organic matter ·015.

Character, bright and colourless. Hardness 0.

One of those remarkable waters in which the lime originally present has been replaced by soda.

The only question in regard to fitness for domestic supply, its organic purity being satisfactory, is whether the 46 grains per gallon of carbonate of soda would be an objection for potable uses. For manufacturing purposes and for washing no better water could be desired.

In a later letter (November 10th, 1891) he says:—

"It is the degree of alkalinity which is remarkable."

"I have no experience of such a water."

He thinks that the carbonate of soda would be harmless.

A later analysis (August, 1898). Made and communicated by Dr. J. C. THRESH. Partly published in his *Examination of Waters and Water. Supplies,* 1904.

Saline constituents, in parts per 100,000.

Ca. ·16	Mg. ·04	Na.	CO$_3$. 37·2	Cl. 15·1	NO$_3$. ·18	Probable combinations.	
·16	—	—	·24	—	—	Calcium carbonate ...	·4
—	·04	—	·1	—	—	Magnesium carbonate	·14
—	—	28·3	36·9	—	—	Sodium carbonate ...	65·2
—	—	9·8	—	15·1	—	Sodium chloride ...	24·9
—	—	·1	—	—	·18	Sodium nitrate ...	·28
						Silica, etc.	2·08

Total solid constituents dried at 180° C. 93·

Oxygen absorbed in 4 hours at 27° C. ·048.

The water closely resembles that from the Chalk in Central Essex and some other parts of the London Basin.

Hawkhurst.

1. BABIES' CASTLE. (See p. 152.) The water comes from the Hastings Beds.

By Mr. G. M. TAYLOR, November, 1893.

Free ammonia	parts per million	·48
Albumenoid ammonia ...	,, ,, ,,	trace
Total solid residue	grains per gallon	20·1
Chlorine (equivalent in common salt, Na Cl, 2·97)		1·8

Alkalinity 15·5°. Hardness 1·8°.

This sample is an extremely pure one. The dissolved salts are precisely similar to those in No. 1 analysis [not to hand], though considerably reduced in quantity. The water has no action on lead. It is extremely soft, and well-suited for washing and cooking purposes; but it would be improved for potable purposes by slight hardening-treatment.

By Mr. W. C. Young, August, 1894.
In grains per gallon.

Total solid residue	22·4
Organic matter in solution	·28
Chlorine as chlorides	1·75
Free ammonia, none. Albumenoid ammonia	·0014
No nitrites or nitrates.	

Hardness 4°.

The water was clear, bright, well aerated, colourless, no odour, slightly alkaline, very soft, of high organic purity, and gave no evidence of present or past sewage pollution.

2. Soper's Lane. Cranbrook District Waterworks.

The water comes from Tunbridge Wells Sand.

By Dr. O. Hehner. Two analyses, in parts per 100,000.

Chlorine	2·35	2·2
Nitric acid	·82	·86
Phosphoric acid	faint trace	very faint trace
Free ammonia	·0004	·0029
Albuminoid ammonia	·0056	·0037
Oxygen absorbed from permanganate in 15 minutes at 80° F.	·0072	·0199
Oxygen absorbed from permanganate in 4 hours at 80° F.	·0253	·0388
Total solids	8·08	9·04

Colour in both, faint blue.

"Both samples are much alike in composition. They contain but a very small amount of dissolved mineral matter, and are in consequence unusually soft."

"The proportion of dissolved organic matter is equally minute, and there is not the least evidence of the presence of animal matter."

"As far as chemical analysis is capable of deciding, both waters are quite free from sewage pollution."

"Both minerally and organically, they are of excellent quality. They are well suited for drinking and for general domestic purposes."

Headcorn. Southernden Farm (? about 2½ miles E.N.E. of the Church). December, 1901.

Well 60 feet deep. Water from Weald Clay.

By A. D. Hall, Principal of Wye College. In parts per 100,000.

Nitrogen as ammonia (none as nitrates or nitrites)	·074
Nitrogen, organic (albumenoid ammonia)	·026
Oxygen absorbed	·496
Chlorine	35·3
Hardness equivalent to carbonate of lime... ...	114·3
Total solids	404·8

The solids consist chiefly of sulphates of magnesia and lime. Contains enough Epsom salts to make a fair aperient water. There is some iron, but no phosphates.

Herne.

1. Blean Union Workhouse. Nearly two-thirds of a mile S.W. of the Church. Received January 31st, 1902.

By S. Harvey. Communicated by Dr. F. Parsons, who remarks that the water is from a well 126 feet deep, and that the yield is 13,200 gallons a day, after five days' continuous pumping. Mr. Harvey notes the well as 140 feet deep, and that it contained about 2 feet of water when the sample was taken from the rising main.

Appearance tolerably clear. No smell.

Microscopical examination of deposit. Chalk chiefly.

	Grains per gallon.
Chlorine in chlorides	9·03
Nitrogen in nitrates	·04
Ammonia	·0448
Albumenoid ammonia	·0019
Oxygen aborbed in 15 minutes, trace only.	
„ „ „ 4 hours	·034
Total solid matter	51·24

Hardness before boiling 21·5, after boiling (permanent) 3·7.

This sample represents water from the Lower Tertiary beds in the district, hence the high figures for chlorine and ammonia. The water is very pure organically and there is no evidence of sewage-percolation, while the hardness is not greatly in excess of that of chalk-water in the neighbourhood.

2. Waterworks.

Water from the Chalk, and partly perhaps from Lower London Tertiary Sands.

Ford, new Well. November, 1883. (See p. 153.)

For earlier analyses see further on. (? from older well).

By G. M. Taylor. Communicated by Dr. F. Parsons.
In grains per gallon.

Free ammonia (parts per million ·052)	·00364
Albumenoid ammonia (parts per million ·04) ...	·0028
Chlorine (equivalent to chloride of sodium 5·84)	3·54
Total solid residue, dried at 220°	25·7

Hardness 18·6°. Alkalinity 14°.

The sample was extremely bright and clear and comes into the class of best and purest waters. The solid residue consisted almost wholly of carbonate of lime, with a trace of sulphate of lime. No iron in solution.

The water is extremely well-suited for domestic and dietetic supplies.

A later analysis (October, 1903), made and communicated by Dr. J. C. Thresh, is as follows, and was partly published in his *Examination of Waters and Water Supplies*, 1904.

Saline constituents, in parts per 100,000.

Ca. 1·35	Mg. 1·	Na. 37·8	K. 3·	CO_3. 17·5	SO_4 28·5	Cl. 23·3	NO_3. ·1	Probable combinations.
1·35	—	—	—	2·	—	—	—	Calcium carbonate ... 3·35
—	1·	—	—	2·5	—	—	—	Magnesium carbonate 3·5
—	—	10·	—	13·	—	—	—	Sodium carbonate ... 23·
—	—	—	3·	—	3·7	—	—	Potassium sulphate... 6·7
—	—	11·9	—	—	24·8	—	—	Sodium sulphate ... 36·7
—	—	15·2	—	—	—	23·3	—	Sodium chloride ... 38·5
								Silica, etc. ... ... 2·25

Total solid constituents dried at 180° C. 114·

Free ammonia	·072
Organic ammonia	·004
Oxygen absorbed in 4 hours at 27° C.	·0105

Dr. Thresh remarks that this water resembles the deep Chalk-water of Mid Essex, save that it contains a little potassium-salt. Although he gives it as from Ford, yet, as he notes that the well was 365 feet deep and 70 feet in Chalk, I think it must have come from the older works at Sharper's Hill. Moreover the analysis does not agree with other results from the new source.

The following analysis (Ford supply) is of water taken from a tap off the main in June, 1907. It was made by Mr. S. HARVEY and communicated by Dr. F. PARSONS.

Appearance clear, green-blue. No smell.

Chlorine in chlorides	8·82	Grains per gallon.
„ expressed as salt	14·54	
Nitrogen in nitrates	·04	
Ammonia	·0019	
Albumenoid ammonia	·0022	
Oxygen absorbed in 15 minutes	trace	
„ „ „ 4 hours	·04	
Total solid matter	41·44	

Hardness before boiling 18·1°, after boiling (permanent) nominal.

Microscopical examination of deposit, organic deposit.

"The above results are generally satisfactory and indicate water organically pure. . . The microscopic examination is also satisfactory."

The earliest analysis (1876), of the water of the public supply, that has been got is by G. W. WIGNER, in *The Water Supply of Sea-side Watering-places*, 1878, p. 23, and he compares it with that of a sample from the well of a house where a death was attributed to the bad quality of the water. The two results were as follows, in grains per gallon.

	Town Supply.	Private Well.
Total solid matter	36·8	107·7
Loss on ignition after deducting combined carbonic acid	2·	34·06
Iron, traces	—	—
Chlorine calculated as chloride of sodium	7·6	39·91
Nitrogen as ammonia	·003	·045
„ „ albuminoid ammonia	·006	·005

Hardness, Clark's scale, before boiling 28° and 50°, after boiling 9° and 44°.

Public supply free from suspended matter, satisfactory taste and smell. Microscopic examination showed imperfect filtration.

Well-water, traces of suspended matter, offensive smell, bad colour, objectionable taste.

One is inclined therefore to think that the above conclusion as to the cause of death was not baseless.

In the same work, pp. 24, 25, he also gives the following two analyses, in grains per gallon (1877).

	Public Supply.	Pump.
Total solid matter	35·7	57·9
Loss on ignition after deducting combined carbonic acid	4·4	5·7
Iron, slight trace	—	—
Chlorine calculated as chloride of sodium	7·84	17·8
Nitrogen as ammonia	·0007	·03
„ „ albuminoid ammonia	·0012	·0057
„ „ nitrates, traces	—	—
„ „ nitrites	·02	·02
Total nitrogen in these four forms	·0219	·0557
Oxygen absorbed by organic matter	·0256	·0416

Hardness, Clark's scale, before boiling 16·5° and 14°, after boiling 6° and 13°.

"These results (the public supply) are therefore fairly concordant with those of last year, as regards solid matter; but on the whole, and especially in reference to albuminoid ammonia, more satisfactory." An excellent water in nearly every respect. A conclusion modified later (p. 58) as a sample, "developed an offensive smell, after standing for a few days," so that he ranks it "as a second class water instead of a first-class one."

Of the second he remarks:—"There is a public pump on the parade, within a very short distance, probably not more than 10 or 20 yards, of the sea; it is said the water from this is not used for drinking purposes, but at the time of my visit a number of children were drinking from a ladle attached to the spout of the pump."

"The sample was milky in appearance, from the presence of considerable quantities of suspended matter, which . . . appeared to consist mainly of clay. The general microscopic appearance was satisfactory." The saline character is the worst fault.

Probably this pump has been disestablished for some time. Mr. Wigner's analyses of the water from the public supply must refer to the old source, near the town.

Hever. THE WARREN. About three-quarters of a mile S.W. of the Church. The water from the Hastings Beds?

Analyses made (1894) and communicated by Mr. D. A. SUTHERLAND. In grains per gallon.

	House Well.	Garden Well.
Ammonia, albuminoid	·002	·0036
Chlorine	3·1	6·2
Alkalinity, as carbonate of lime	7·5	25·
Total solids	16·	63·
No free ammonia or nitric acid		
Hardness (temporary)	7°	25°
Residue		
Silica	·5	·5
Iron and alumina	1·25	1·
Carbonate of lime	6·7	25·1
Carbonate of magnesium	·67	·32
Sulphate of lime...	·952	16·8
Sulphate of magnesium	—	8·15
Chloride of calcium	2·322	—
Chloride of magnesium...	2·532	4·02
Chloride of sodium	—	5·28
Organic matter, etc.	1·074	1·83
Total solids	16	63

House Well.

Microscopical Examination of Deposit.

That of one sample very unsatisfactory, showing vegetable débris, mineral matter, fabric, etc. That of sample taken on Sept. 25 (from which the above analysis was made) more satisfactory.

Bacteriological Examination.

No pathogenic organisms obtained; but the cultivations showed a considerable number of colonies to be present, several of which were of the unsatisfactory type known as liquefying. The number of species of bacteria comparatively large, several indicating surface-contamination.

Conclusions.

The depth of the well, only some 30 feet, is insufficient to ensure the water being free from surface-contamination, and it is lined only with uncemented bricks. Distinct evidence of soakage from surface-water was noticeable on the side furthest from the house, in dry weather.

The complete chemical analysis is satisfactory, the water being free from sewage-contamination. The high percentage of chlorine is accounted for in combination with lime and magnesia.

The bacteriological examination is not satisfactory and in wet weather the water might be made dangerous, especially in the event of leakage from drains.

Garden Well.

Microscopical Examination of Deposit.

Shews vegetable débris, etc., and is unsatisfactory, probably from the sample being taken from the surface, by means of a bucket.

Bacteriological Examination.

No pathogenic micro-organisms isolated, but the result was very unsatisfactory, there being a large number of colonles and of species, several of which proved surface-contamination.

Conclusions.

The analysis shows the water to be too hard and unsuitable for potable purposes, at all events without softening and filtering.

The structure of the well is like that of the house well.

Hinxhill.

Willesborough Public Supply, April 5th and 12th, 1899. (See p. 155.) Water from Folkestone Beds.

By Messrs. Dibdin and Thudichum. The second sample after seven days' continuous pumping. Communicated by Dr. F. Parsons. In grains per gallon.

In both appearance green and slightly turbid. No odour at 100° F. No blackening on ignition of solids.

	1.	2.
Total solids	21·9	17·2
Phosphoric acid, very slight trace in both ...	—	—
Free ammonia	·0039	·0038
Albumenoid ammonia...	·0036	·0006
Chlorine...	2·3	2·05
Oxygen absorbed from permanganate at 80° F. in 15 minutes	·0729	·0741
Oxygen absorbed from permanganate at 80° F. in 4 hours	·1533	·1013
Nitrogen as nitrates, trace in both...		

	1.	2.
Total hardness...	13·5°	12·4°
Permanent hardness	7·4°	6·3°
Cultivation on gelatine plates. Colonies per c.c.	21,850	1,373
Micro filter m.m. per litre	14	15·6
Pathogenic organisms not detected in either		

Microscopical examination. At the boring, no specific organic matter; but large numbers of bacilli and micrococci; fine grey and green sand with much mica, etc. At Willesborough, very fine green sand and grit; no detectable organic matter; but enormous quantities of very small bacilli and micrococci.

From the above it will be noticed that the effect of the continued pumping has been very satisfactory, the reduction in the ammonia yielded by the albuminous matters being five-sixths of the amount on the 5th. The large number of bacteria found was also reduced greatly. The reduction in chlorine is also satisfactory. The bacteriological results point to the advisability of continued pumping [before using the water]. In all other respects this is an excellent water.

Hougham. DOVER COLLIERY. (See p. 227.)

Analyses of the water that broke in to the Shaft No. 2. From Mr. J. GERRARD's Report (quoted on p. 230), p. 21.

"Explorations have proved, since the accident, the water came from two sources. One supply being cold, fresh water, having a temperature of 58° Fahrenheit. This is probably lower greensand water." Its analysis is given in the first column of figures below. "The other source was from the bore-hole. . This has a temperature of 80° Fahrenheit." Its analysis is in the second column of figures. In grains per gallon.

Total solids dried at 212° F.	52·08	841·12
Chlorine as chlorides ...	1·863	449·785
Total hardness	1·05° Clark a very soft water	69·65° (temporary 21°) a very hard salt water
Temperature	58° F.	80° F.
Analysis of solids		
Carbonate of lime ...	·617	21·
Carbonate of magnesia	·424	0
Carbonate of soda ...	22·26	0
Sulphate of lime ...	0	2·124
Sulphate of soda	143·23	0
Chloride of calcium ...	0	23·753
Chloride of magnesia ...	0	24·43
Chloride of sodium ...	3·071	686·07
Silica	1·12	·7
Alumina	·56	·28
	—	charged with firedamp

[The salt in the second result is suggestive of communication with the sea; but the temperature is not so.]

Hythe. Public Supply, partly from Springs, partly from Wells. (See pp. 64, 187—189.) Water from Lower Greensand.

By G. W. WIGNER, *The Water Supply of Sea-side Watering-places,* 1878, pp. 53, 54. In grains per gallon.

Total solid matter	35·4
Loss on ignition after deducting combined carbonic acid	8·55
Iron, very slight trace	
Chlorine calculated as chloride of sodium	4·8
Nitrogen as ammonia	·0009
,, ,, albumenoid ammonia	·003
,, ,, nitrates	·234
,, ,, nitrites	·004
Total nitrogen in these four forms	·2419
Oxygen absorbed by organic matter, traces	

Hardness, Clark's scale, before boiling 17·7°, after boiling 4·4°.

Sample pale blue, free from suspended matter. Microscopic results quite satisfactory. The only objectionable feature a slightly unpleasant taste. On the whole a good water.

See also **Saltwood.**

Ightham. HEATHER BANK. Drawn 13th May, 1885.

Communicated by Mr. B. HARRISON.

Depth of well 35 feet. In Folkestone Beds (or possibly Sandgate Beds).

Free ammonia ...	·008	Parts per million.
Albumenoid ammonia	·04	
Oxygen consumed ...	·50777	
Total solid residue...	9·38	Grains per gallon.
Chlorine	2·8	
Sulphates	·01904	
Iron, minute traces		

Hardness, temporary 1°, permanent 2°.

This water was turbid. Some of the suspended matter, which refused to settle completely for a long time, was very fine, passing through the filter-paper. It was insoluble in acids. Its quantity did not exceed 4 parts per million, and, as far as could be found, it was chiefly inorganic and innocuous.

The water is slightly acid (carbonic acid).

The residue, under the microscope, seemed mostly granular.

The water had no smell and tasted pure, not unlike rain-water. It is fit for drinking-purposes, when the turbidity is removed.

Another account describes the well as at Ightham Knoll and 25 feet deep. The analysis was made by H. F. SOWERBY, who remarks that "the above figures are no guarantee of the continued freedom from objection after a long interval, and such a water should be examined again from time to time."

Kemsing. TRIAL-BORING for SEVENOAKS WATERWORKS.

(See p. 157.) Water from Lower Greensand.

Made (July, 1907), and communicated by Dr. J. C. THRESH. Saline constituents, in parts per 100,000.

Ca. 6·45	Mg. ·05	Na.	CO_3. 8·5	SO_4. 2·25	Cl. 2·2	NO_3. ·04	Probable combinations.	
5·6	—	—	8·5	—	—	—	Calcium carbonate...	14·1
·85	—	—	—	2·1	—	—	Calcium sulphate ...	2·95
—	·05	—	—	·15	—	—	Magnesium sulphate	·2
—	—	1·45	—	—	2·2	—	Sodium chloride ...	3·65
							Silica, etc.	·9

Total solid constituents dried at 180° C. 21·8

Free ammonia (no organic ammonia or nitrites) ·002.

Keston. UPPER NASH COTTAGES (not so named on newer Ordnance Map. ? westward of the village). The nearest well (at the time) to the proposed Pumping Station of the Metropolitan Board of Works at Keston. 160 feet deep, the water (from the Chalk) standing 218 feet above Ordnance Datum.

By Dr. A. J. BERNAYS. Collected October 7th, 1878. From MSS. Papers of Sir J. PRESTWICH. In grains per gallon.

Potassoxide	·2	[Total 21·86.]
Sodium-oxide ...	·51	
Calcium-oxide ...	9·94	
Magnesia	·42	
Chlorine	·85	
Carbon-dioxide ...	7·32	
Sulphur-trioxide ...	·4	
Nitrogen-pentoxide	1·61	
Silica	·61	

These are probably combined as follows:—

Sodium-chloride ...	·97
Potassium-sulphate	·36
Calcium-sulphate ...	·41
Calcium-chloride ...	·4
Calcium-nitrate ...	·73
Calcium-carbonate	16·64
Magnesium-nitrate	1·55
Silica...	·61
Free ammonia ...	·0017
Albumenoid ammonia	·0007
Nitrogen (oxydised)	·417

[Total 21·67.]

Total residue 21·06.
Hardness before boiling 17·6, after boiling 2·85.

A sample taken in March, 1878, gave Dr. BERNAYS the following result (Sir J. PRESTWICH'S MSS. Papers).

	Grains per gallon.	Parts per 100,000.
Total solid matter...	19·75	28·22
Chlorine	1·32	1·88
Ammonia, free	·0022	·0032
Ammonia, albumenoid	·0053	·0076
Organic carbon	·019	·027
Organic nitrogen	·008	·012
Nitrogen as nitrates and nitrites	·386	·552

Hardness 16·27, permanent 3·91.

Littlestone, etc. Water Co., *see* **Lydd**, p. 279 and **New Romney**, p. 330.

Lower Halling. MID KENT WATER CO. (See p. 162.) Water from Folkestone Beds. Sample taken from the Main

Made and communicated by Dr. J. C. THRESH. Mostly published in his *Examination of Waters and Water Supplies*, 1904. Saline constituents, in parts per 100,000.

Ca. 5·6	Mg. ·5	Na. —	CO_3 9·6	SO_4 ·5	Cl. 1·9	NO_3 ·25	Probable combinations.	
5·6	—	—	8·4	—	—	—	Calcium carbonate ...	14·
—	·5	—	1·2	—	—	—	Magnesium carbonate	1·7
—	—	·25	—	·5	—	—	Sodium sulphate ...	·75
—	—	1·25	—	—	1·9	—	Sodium chloride ...	3·15
—	—	·1	—	—	—	·25	Sodium nitrate ...	·35
							Silica, etc.	1·55

Total solid constituents dried at 180° C. 21·5

Organic ammonia (no free ammonia or nitrites) ·001
Oxygen absorbed in 4 hours at 27° C. ... ... ·02

An analysis made for the South Kent Water Co. in November, 1904, is as follows. From Dr. J. S. Tew's Annual Report (Tunbridge Rural District) 1904. In parts per 100,000.

Ammonia, free (no albumenoid) ...	·001
Oxygen absorbed in 15 minutes,	none
,, ,, ,, 4 hours... ...	·005
Chlorine	1·6
Nitrogen as nitrates and nitrites,	trace
Total solid residue	23·6

"The usual very high degree of purity is fully maintained."
Hardness, total 17·6, permanent 4·2, temporary 13·4.

Another analysis March 1907 (Water Works Directory 1907).

Ammonia, free	·004	Parts per 100,000.
,, albuminoid	·0016	
Oxygen absorbed in 15 minutes ...	none	
,, ,, ,, 4 hours	·01	
Total solid residue	24·8	
Chlorine	1·8	
Nitrogen as nitrates and nitrites ...	trace	

Hardness 17·2; temporary 12; permanent 5·2.

Lydd. From the deep boring at the Camp. (See p. 163.)

Water from the Hastings Beds.

Made and communicated by Prof. De Chaumont. July, 1885. Well 270 feet deep [more since].

Whitish. Turbid. A great deal of sediment. Dull vitreous lustre. Brackish taste. No smell.

Qualitative analysis (water unconcentrated.)

Lime, copious.
Magnesia, present.
Chlorine, very large amount.
Sulphuric acid, very large.
Phosphoric acid, trace.
Ammonia, very large.
No nitric or nitrous acid [but see below].
Oxidisable matter, trace.
No iron.
Hardness, fixed 26·25°, temporary 5·25°, Clark's scale.

Quantitative analysis.

Volatile matter (by incineration and after re-carbonating) ...	12·95
Chlorine	224·
Calcium carbonate	3·5
Fixed hard salts	26·25
Sulphuric acid (SO_4)	140·77
Alkaline carbonates	
Sodium or other metal (combined with Cl or SO_4) not included in fixed hard salts	
Silica, alumina, iron, etc.	
Total solids (by evaporation) ...	407·47

The above in grains per gallon. The following in parts per million.

Oxygen required for oxidisable organic matter	2·02
Ammonia, free	4·08
Ammonia, albumenoid	·0504
Nitric acid (NO_3)	2·2684
Nitrous acid (NO_2)	1·38

Microscopic characters.—A very large quantity of grey sediment, chiefly aluminium and silica, with a trace of iron.

This water is unfit for use, on account of the enormous quantity of salt contained in it. The free ammonia is in remarkable excess; but this is found sometimes in deep well-water which is otherwise usable.

Maidstone. MEDWAY MILLS. (See p. 167.) 1901.

Made by Messrs. CROSS and BEVAN. Communicated by Messrs. BALSTON, who remark that the alkalinity is due almost wholly to sodium-carbonate.

	1.	2.	
Total solids	92·5	84·6	Grains per gallon.
Alkalinity	22·	22·	
Iron - oxide	1·04	trace	
Lime ...	·84	1·29	
Magnesia...	·5	·5	

Hardness 20·75° and 30·55°.

Apparently these analyses are of water reached at the depth of 125 feet and in this 16·5 grains of sodium-carbonate were found. This water must come from the Weald Clay.

WATERWORKS, *see* **Boxley.**

Margate. WATERWORKS. (See p. 168.)

Water from the Chalk, except in the last case, p. 328.

Notes on the water from the Tivoli Pumping Station (abandoned), from Mr. A. LATHAM.

1858. May. Mr. WILLS' analysis showed 35·85 grains of total solids, including 7·8 of common salt, in a gallon.

1866. Dr. FAULKNER'S analysis showed an increase to 43·47 grains of total solids, and the water contained much common salt and enough nitrates and nitrites to show that it was not free from animal contamination.

1868. July. There were 46 grains of total solids and it was advised that the water was somewhat brackish.

1874. January. Dr. LETHEBY found 45·06 grains of solids, 19·58 of which were salt, and the hardness was 24·8°. He thought that the water was not fit for domestic use. Dr. TIDY confirmed this five weeks later, saying that "the water might at any time, if the process of oxidation was interfered with, become very injurious."

1876, 7. Winter. Prof. WAY said that there was percolation of sea-water, which accounted for the excessive hardness.

1882. April and May (a time when the springs are full) Mr. HARVEY found, in a sample from the pumping-well, 24·22 grains of salt and 55·3 of total solids to a gallon. At first the water from the new adit showed much less salt and total solids, and the improvement was maintained until, the springs being lowered by pumping, it rose to 40 grains of salt and 70·7 of total solids.

At a later date, a sample taken in the early morning, before the commencement of pumping, yielded a greater amount of salt than had been found under similar conditions, and the microscopical examination showed living organisms. There were 37·03 grains of salt and 66·57 of total solids to a gallon, while the nitrogen or nitrates was ·955, which is in excess. A sample taken at the close of a day's pumping yielded 88·9 grains of solid matter, of which 59·29 were of salt.

1886. September. The borough-analyst reported that the results of analyses pointed to sewage-percolation and admixture of sea-water.

In a joint report of December, 1886, Dr. W. K. TREVES and Mr. A. LATHAM say :—"The growth of the town in this direction and the encroachment of inhabited houses and cesspools in the immediate vicinity . . is the cause of this; the evil having become more pronounced as buildings have been erected and cesspools sunk within a very limited distance from the well, and which will be aggravated in tho immediate future, from the fact that the land at Tivoli and at Salmstone . . immediately above the main source of supply . . will shortly be built upon."

"Under these disquieting circumstances and [considering] the prevalence of Typhoid Fever in the town, which we are afraid must be laid to the questionable character of the water, we recommend either that the use of the well at Tivoli for the water-supply of the town should be discontinued or that special works should be undertaken for the proper drainage of this portion of the district."

The above is of interest as showing the gradual falling off in quality of water got by heavy pumping near to the sea, and also the indrawing of polluting matter by such pumping. A supply that originally was good, and which might have kept so, or at all events might have been only slightly affected, if but light pumping had been set up (which obviously could not be the case with a supply for an increasing town of fair size), had to be abandoned.—W. W.

The following two analyses are from a small pamphlet, "Analyses of the Main Water Supply of Margate at the Tivoli Pumping Station," reprinted from *Keble's Margate and Ramsgate Gazette*, of 16th April, 1887, the object of which was to make out the excellence of that supply.

1. By Dr. J. MUTER. Sample taken from man-hole nearest Tivoli Garden, at 10.10 a.m. 20th October, 1886. In grains per gallon.

Appearance in two-foot tube, colourless and clear.
Smell, when heated to 100° F., slightly earthy.
Microscopical examination satisfactory.

Chlorine	28·5
Phosphoric acid, trace	
Nitrogen as nitrates	·88
Ammonia	·0007
Albumenoid ammonia	·0007
Oxygen absorbed by organic matter in 15 min. at 80° F.	·004
,, ,, ,, ,, ,, ,, 4 hours ,, ,,	·008
Total solid matter, dried at 220° F.	82·

Hardness, Clark's scale, before boiling 25°, after 15°.

Dr. MUTER suggests that such great salinity "is the character of nearly all well supplies close to the sea coast" and that the amount of nitrates is "only what is to be expected" from a deep well, and he thinks that freedom from organic impurity makes the water passable.

By Prof. J. ATTFIELD. From the same source, at 11.30 a.m. 29th March, 1887. In grains per gallon.

Total dissolved solid matter (none suspended) dried at 250° F.	46·
Nitrates, containing 17 per cent. of nitrogen (no nitrites or ammonia)	1·35
Chlorides, containing 60 per cent. of chlorine (= chlorine 14·2)	23·7

Hardness before boiling 19°, after 12°.
Physical examination satisfactory.

In a letter Prof. ATTFIELD adds that the quantity of saline substances is insignificant, and that the water is remarkably free from contamination and of good quality.

May not these two analyses serve to show the danger of trusting to such evidence by itself, without consideration of the surroundings, etc., of the source of supply? Moreover, the high chlorine is a distinct warning of something being wrong.—W. W.

The following two analyses are by G. W. WIGNER, in *The Water Supply of Sea-side Watering-places*, 1878, pp. 26-28.

1. Drawn from a public drinking-fountain, July 14th. 2. Sample sent by the Secretary of the Water Co., July 30th (1877 ?), drawn from the old (Tivoli) well. [1 is apparently derived mostly from the same source, though there was a newer well at the time.]

	1.	2.
Total solid matter	64·2	68·6
Loss on ignition after deducting combined carbonic acid	9·3	12·39
Iron, traces.		
Chlorine calculated as chloride of sodium ...	32·76	33·7
Nitrogen as ammonia	·0025	·0072
,, ,, albumenoid ammonia	·006	·0045
,, ,, nitrates	·848	·422
,, ,, nitrites	·014	·008
Total nitrogen in these four forms	·8705	·4417
Oxygen absorbed by organic matter	·0272	·25

Hardness, Clark's scale, before boiling 24° and 19°, after boiling 10·4° and 7°.

Both dirty blue, with heavy traces of suspended matter, with a slightly offensive smell when warmed and a bad saline taste. Microscopic examination showed the presence of a great deal of vegetable matter.

A comparison with an analysis of the year before (? 1876) shows a decrease of total solids, chlorine and volatile matters, and a large decrease in albumenoid ammonia. Nevertheless Mr. WIGNER advocates the abandonment of the old well.

The following analyses of water from the Tivoli Pumping Station are taken from Dr. D. PAGE's *Report to the Local Government Board on the Sanitary Condition of Margate*, 1887, pp. 10, 11. They are by S. HARVEY, and the dates are those of the reception of samples. Results in grains per gallon.

In all appearance clear. No smell. Hardness not given.

	Nov. 21st, 1885.	Dec. 9th, 1885.	Sept. 10th, 1886.	May 4th, 1887.
Total solid matter...	66·57	88·9	105·7	61·53
Chlorine in chlorides	22·47	35·98	42·91	19·11
Chloride of sodium...	37·03	59·29	70·71	3·49
Phosphoric acid in phosphates ...	Distinct traces	Distinct traces	Traces	Traces
Nitrogen in nitrates	·955	·848	·93	·92
Ammonia	·0008	·0015	·0042	·0009
Albumenoid ammonia	·0014	·0028	·0035	·0022
Oxygen absorbed in 15 minutes ...	—	—	—	—
Oxygen absorbed in 4 hours	·052	·036	·045	·028
Microscopical examination of deposit	Starch, dyed fibres and living organisms	Slight only	Slight only	Organic matter, starch, dyed fibres

The results point to sewage-percolation and admixture of sea-water, and confirm those of Mr. WIGNER, 1878, see above.

Notes on the water from the Dane Pumping Station.
From Mr. A. LATHAM.

1874. May. An analysis by Prof. ATTFIELD showed 30 grains of solids (7·1 of salt) and some small proportion of other matter.

1879. Mr. OGSTON's analysis showed total solids 34·6 (salt 6·51), nitrates and nitrites ·33. He says that the water is unexceptionable so far as wholesomeness is in question, and is a good potable water.

1882? Mr. S. HARVEY found 31·71 grains of total solids, of which 6·11 were salt, to the gallon; but the nitrogen or nitrates was more than it should be.

DRINKING-FOUNTAIN, by Station.

Made and communicated by C. EKIN.

Chlorine	1035·	Parts per million.
Ammonia	·12	
Nitrogen as nitrates (no nitrites)	9·88	

From the deep Boring (850 feet) at the Dane Pumping Station. (See p. 169.) Taken at midnight August 11th, 1899.

This water may come, in part at least, from Lower Greensand.

Made and communicated by S. HARVEY.

Temperature of the water when taken 64° F. Green-blue and clear. No smell. Taste saline and alkaline.

Mineral constituents, in grains per gallon.

Sodium chloride	139·59	Total solid matter 178·64.
Sodium sulphate	1·45	
Sodium carbonate	23·73	
Potassium chloride... ...	1·76	
Magnesium carbonate ...	3·81	
Calcium carbonate	3·87	
Calcium phosphate... ...	·44	
Silica	1·19	
Iron-oxide	·05	
Suspended matter, loss, etc.	2·75	

Gaseous constituents, in cubic inches per gallon at normal temperature and pressure.

Oxygen ...	1·87	Total gas 8·37.
Nitrogen ...	4·41	
Carbonic acid	2·09	

Organic analysis, in grains per gallon.

Free ammonia	·0924
Albumenoid ammonia...	·0017
Oxygen absorbed in 15 minutes, trace only	
" " " 4 hours	·056
Nitrogen in nitrates	·02

Metropolitan Water Board.

KENT WATER Co. From Main at St. Mary Cray. 1899.

Water from the Chalk.

Made and communicated by Dr. J. C. THRESH. Mainly printed in his *Examination of Waters and Water Supplies*, 1904.
Saline constituents, in parts per 100,000.

Ca.	Mg.	Na.	CO_3.	SO_4.	Cl.	NO_3.	Probable combinations.	
9·65	·2	—	13·5	·8	1·4	2·2		
9·	—	—	13·5	—	—	—	Calcium carbonate	22·5
·35	—	—	—	·8	—	—	Calcium sulphate ...	1·15
·3	—	—	—	—	·5	—	Calcium chloride ...	·8
—	·2	—	—	—	·6	—	Magnesium chloride	·8
—	—	·2	—	—	·3	—	Sodium chloride ...	·5
—	—	·8	—	—	—	2·2	Sodium nitrate ...	3·
							Etc.	·25

Total solid constituents dried at 180° C. 29·

Free ammonia	·001
Organic ammonia	·002
Oxygen absorbed in 4 hours at 27° C.	·02

There are many analyses of organic matters, etc., of the Kent Water Co., generally in *Royal Commission on Water Supply.* Appendix to the Minutes of Evidence, fol. 1869, pp. 80-95, 122. Also in the *Sixth Report of the Rivers Pollution Commission*, 1874, pp. 440-458.

See also **Beckenham**, p. 287, **Belvedere (Erith)**, p. 303, **Bexley**, p. 288, **Crayford**, p. 296, **Deptford**, p. 298, **Plumstead**, p. 332, **Westerham**, p. 350.

Mid Kent Waterworks, *see* **Charing** and **Lower Halling**.

Milton by Sittingbourne. WATERWORKS. (See p. 172.) Water from the Chalk.

By Sir T. STEVENSON, July, 1904. In grains per gallon.

Communicated by Dr. F. PARSONS, who adds that the sample was from a tap on the rising main at the pumping-station, and that the source is a well in the Chalk.

Free from odour and, when viewed in bulk, colourless and clear.

Total solid matter	23·52
Loss on ignition	1·96
Combined chlorine (= common salt 2·24)...	1·36
Nitrogen as nitrates (no nitrites)	·27
Ammonia	·001
Albumenoid or organic ammonia	·0025
Oxygen required to oxidise organic matter	·013

Hardness, temporary 17·6°, permanent 1°.

An excellent water for a public supply. The organic purity is very high and there is no evidence of the presence of polluting matter.

? Minster. HOSPITAL OF THE ISLE OF THANET JOINT HOSPITAL BOARD. February, 1902. Water from the Chalk.

By S. HARVEY, Public Analyst. Communicated by Dr. F. PARSONS.

Well 155 feet deep, with adits, in the Chalk.
Yield about 10,000 gallons a day.
Appearance, clear. Colour, green-blue. No smell.

Chlorine in chlorides...	3·36	Grains per gallon.
Nitrogen in nitrates	·51	
Ammonia, trace only		
Albumenoid ammonia	·0014	
Oxygen absorbed in 15 minutes, trace only		
,, ,, ,, 4 hours	·025	
Total solid matter	30·44	

Hardness before boiling 19·2, after boiling 1·6.

"The above results are satisfactory throughout and indicate water organically pure by sewage-percolation. The microscopical examination calls for no adverse remarks."

Dr. KLEIN made a bacteriologic examination (May, 1902). He says:— "The water was not quite limpid, containing a large number of minute particles, almost microscopic in size, suspended in it."

It contained about 900 bacteria per cubic centimetre; these were all of the ordinary kind, from water and soil, harmless; amongst them nearly 60 per cent. of the ordinary *Bacillus fluorescens liquereus.* This he believed was due to the well being of recent construction, "and therefore we may expect for some time this species, which is really derived from soil, will be abundantly present in the water."

The water did not yield any *Bacillus coli communis.*

"No anaerobic bacteria, pathogenic or non-pathogenic, were discovered."

"I am inclined to consider the sample as of good quality, that is to say, devoid of any obnoxious bacteria, and further that in time the number of bacteria in the well-water will considerably decrease."

New Romney. Supply for LITTLESTONE-ON-SEA.

Water from shingle or sandy alluvial beds. Sample taken from the shallow well north of Littlestone after six hours' pumping, September 5th, 1903.

By Sir T. STEVENSON. Communicated by Mr. A. F. PHILLIPS.

Slightly yellow. No odour. Very slight turbidity.

In grains per gallon.

Solid matter	137·76
Loss on ignition	14·86
Chlorine (= common salt 97·66)	59·19
Lime	10·91
Magnesia	9·03
Nitrogen as nitrates	·02
Nitrites, traces	
Ammonia	·018
Albumenoid or organic ammonia	·015
Oxygen required to oxidise organic matter	·118

For an analysis of the new supply see p. 279.

Orpington. COCKMANNINGS. (See p. 175.) April, 1899.

Water from the Chalk.

Made and communicated by Dr. J. C. THRESH.

Saline constituents, in parts per 100,000.

Ca. 13·1	Mg. ·5	Na. —	CO_3. 14·2	SO_4. 1·4	Cl. 7·1	NO_3. 8·5	Probable combinations.	
9·5	—	—	14·2	—	—	—	Calcium carbonate	23·7
·6	—	—	—	1·4	—	—	Calcium sulphate ...	2·
2·7	—	—	—	—	—	8·5	Calcium nitrate ...	11·2
·3	—	—	—	—	·5	—	Calcium chloride ...	·8
—	·5	—	—	—	1·5	—	Magnesium chloride·	2·
—	—	3·3	—	—	5·1	—	Sodium chloride ...	8·4
							Silica, etc.	1·4

Total solid constituents dried at 180° C. 49·5

Free ammonia	·005
Organic ammonia	·006
Oxygen absorbed in 4 hours at 27° C.	·03

Dr. THRESH remarks that there must be highly manured ground in the neighbourhood to account for the high nitrates.

Otford.

1. Mr. FREEMAN'S WELL. July, 1898. (See p. 176.)

Water from Folkestone Beds.

Free ammonia ...	·01	Parts per million.
Albumenoid ammonia	·01	
Chlorine	·97	

Total solids 19 grains per gallon.
Hardness 12·5°.

2. Near LONGFORD MILL, DUNTON GREEN. Sevenoaks Rural District Council. (See p. 176.) Water from Folkestone Beds.

By Mr. ADAMS (County Analyst). November, 1889.

Communicated by Mr. T. HENNELL. Works in progress and water turbid.

	Top Spring (Well).	Bottom Spring (Bore-hole).
Total solid matter	24·7	19·1
Loss on ignition	2·2	1·7
Chlorine	1·6	1·
Nitrogen in nitrates	·17	·17
Free ammonia	·02	·02
Albumenoid ammonia	·04	·04
Oxygen absorbed in 15 minutes	·03	·026
,, ,, ,, 4 hours ...	·041	·043
Total hardness (Clark's scale) ...	14°	11°
Permanent hardness, after boiling	2·5°	2·5°
Appearance in 2-foot tube ...	opaque yellowish-green	clear pale green
Smell	--	none

Another analysis made (July, 1907) and communicated by Dr. J. C. THRESH.

Saline constituents, in parts per 100,000.

Ca. 8·25	Mg. ·35	Na. —	CO_3. 10·9	SO_4. 2·	Cl. 1·9	NO_3. ·2	Probable combinations.	
7·3	—	—	10·9	—	—	—	Calcium carbonate	18·2
·8	—	—	—	2·	—	—	Calcium sulphate ...	2·8
·15	—	—	—	—	·25	—	Calcium chloride ...	·4
—	·35	—	—	—	1·4	—	Magnesium chloride	1·75
—	—	·15	—	—	·25	—	Sodium chloride ...	·4
—	—	·1	—	—	—	·2	Sodium nitrate ...	·3
							Silica, etc.	1·45

Total solid constituents dried at 180° C. 25·3

Oxygen absorbed in 4 hours at 27° C. ·008.

Pembury. TUNBRIDGE WELLS WATERWORKS. July, 1904. (See pp. 177—181.) Water from Ashdown Beds.

Made and communicated by Dr. J. C. THRESH.

Saline constituents, in parts per 100,000.

Ca. ·9	Mg. ·3	Fe. ·15	Na. —	CO_3. 9·	SO_4. 3·5	Cl. 3·	NO_3. ·6 ?	Probable combinations.	
·9	—	—	—	1·35	—	—	—	Calcium carbonate ...	2·25
—	·3	—	—	·75	—	—	—	Magnesium carbonate	1·05
—	—	·15	—	·15	—	—	—	Ferrous carbonate ...	·3
—	—	—	5·2	6·75	—	—	—	Sodium carbonate ...	11·95
—	—	—	1·7	—	3·5	—	—	Sodium sulphate ...	5·2
—	—	—	1·95	—	—	3·	—	Sodium chloride ...	4·95
								Silica, etc.	·3

Total solid constituents dried at 180° C. 26·

Free ammonia	·048
Organic ammonia	·004
Oxygen absorbed in 4 hours at 27° C.	·028

The following particulars are by Dr. A. C. HOUSTON, 32*nd Ann. Rep. of the Local Govt. Board, Supplement*, p. 586. (1904.) The figures are parts per million and the samples were taken from October 27th to December 29th, 1902.

Wells.	Free Ammonia.	Albumenoid Ammonia.	Oxygen absorbed from Permanganate in 4 hours.	Chlorine.
1, 2, 3	·024 to ·032	·0024 to ·0056	·019 to ·042	2·1 to 2·3
3	·024 to ·032	·004 to ·0104	·0106 to ·02	2·9 to 3·1
4	·024 and ·028	·0056 and ·0064	·01 and ·0196	2·7 and 3

No. 4 is thought to be substantially the same as No. 3, only 30 feet distant.

"The chemical results as a whole suggest that the waters are of great purity, although the figures as regards free ammonia are certainly high."

A lengthy account of bacteriologic examinations is also given.

Petham. Water from the Chalk.

W. H. HAMMOND, 22*nd Rep. E. Kent N.H. Soc.*, p. 24. (1880.)

1. From well in meadow about a mile from Petham, away from houses.
2. From well close to a farmhouse in Petham.
3. From a well in the middle of the village.
4. From another well at Petham, with a pump.

	1.	2.	3.	4.
Total solids... ...	21·35	29·4	22·4	24·5
Chlorine	1·24	1·74	1·57	1·33
Free ammonia ...	·04	·04	·05	·03
Albumenoid ammonia	·07	·08	·17	·04
Nitrites	—	traces	—	—

In 2 "the presence of the farmyard has raised all the items, but still it may be classed as a wholesome water." He thinks "that the large quantity of water in the soil thoroughly cleanses all the wells."

For an analysis of the Nailbourne-water see p. 280.

Plumstead. THE PLUMSTEAD, WOOLWICH AND CHARLTON CONSUMERS' PURE WATER CO. Absorbed by the Kent Co. in 1861, and now by the Metropolitan Water Board. (See p. 183.) 1867. Water from the Chalk.

Royal Commission on Water Supply. Minutes of Evidence, p. 232. Fol. *Lond.*, 1869.

Hardness of the water	21°	
" " " softened water (Clark's process) ...	7½°	
Solid contents of the water... ...	31	Grains per gallon.
" " " " softened water	18½	

Another analysis, by Prof. A. W. HOFMANN, in a *Report on the Chemical Quality of the Supply of Water to the Metropolis*, 1856. Reprinted in above, p. 123.

a. From works, softened, January 25th. *b.* From well, unsoftened, April 5th.
In grains per gallon.

	a.	*b.*
Total solid residue	18·84	33·163
Organic matter ...	·75	1·05
Inorganic matter ...	18·09	32·113
Hardness, total ...	8·15°	22·65°
„ permanent	8·1°	10·25°
„ temporary	·05°	12·4°

A later analysis. KENT WATER CO.'S WELL, 600 feet deep [now Metrop. Water Board], February 11th, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 101. Repeated pp. 275, 293.

Clear and palatable. Temperature 12° C.

Total solid impurity	50·8	Parts per 100,000.
Organic carbon	·081	
Organic nitrogen (no ammonia) ...	·011	
Nitrogen as nitrates and nitrites	·338	
Total combined nitrogen	·349	
Chlorine	4·6	

Hardness, temporary 16·8, permanent 13·8; total 30·6.

There are six somewhat similar analyses, by Dr. A. J. BERNAYS, in Sir F. BOLTON's *London Water Supply*, 1884, p. 83.

Ramsgate. WATERWORKS. (See p. 184.) Water from the Chalk.

Well at Whitehall, 100 feet deep, March 1st, 1873.
Rivers Pollution Commission. Sixth Report, 1874, p. 100.
Clear and palatable. Temperature 10° C.

Total solid impurity	40·9	Parts per 100,000.
Organic carbon	·052	
Organic nitrogen (no ammonia) ...	·013	
Nitrogen as nitrates and nitrites	·806	
Total combined nitrogen	·819	
Chlorine	5·2	

Hardness, temporary 20·4, permanent 5·9; total 26·3.

Two analyses by G. W. WIGNER, in *The Water Supply of Sea-side Watering-places*, 1878, pp. 30, 31. In grains per gallon.

1. Drawn from the drinking-fountain at the pier-gates, July 14th.
2. From the Surveyor, July 23rd (? 1877).

	1.	2.
Total solid matter	28·5	33·6
Loss on ignition after deducting combined carbonic acid	4·2	4·43
Iron, traces.		
Chlorine calculated as chloride of sodium... ...	6·76	6·67
Nitrogen as ammonia	·0011	·004
„ „ albumenoid ammonia	·0035	·0037
„ „ nitrates	·419	·488
„ „ nitrites	·013	·006
Total nitrogen in these four forms	·4366	·5017
Oxygen absorbed by organic matter	·021	·011

Hardness, Clark's scale, before boiling 19° and 18·6°, after boiling 3·5° and 4·2°.

Both of excellent colour and free from objectionable taste or smell. No fault except hardness.

Five samples, by S. Harvey. Communicated by Dr. F. Parsons. In grains per gallon.

1. From the rising main near Whitehall Works, taken at noon, August 29th, 1890.
2. From the bottom of the well, Southwood, taken at 12.45 p.m. same day.
3. From heading in which workmen were at work ... ... } Received
4. From heading nearest the point where contamination might have been expected ... ... } 30thMay, 1904.
5. Sample received 16th January, 1899.

In all, appearance clear, no smell. Colour, in 5, green-blue.

	1.	2.	3.	4.	5.
Chlorine in chlorides ...	10·36	7·63	3·71	3·71	11·62
Do. reckoned as salt ...	17·07	12·57	—	—	—
Nitrogen in nitrates ...	·85	·85	·35	·33	·69
Ammonia	trace	trace	·0035	trace	none
Albumenoid ammonia ...	·0006	·0019	·0025	·0022	·0011
Oxygen absorbed in 15 minutes	trace	trace	trace	trace	trace
Oxygen absorbed in 4 hours	·03	·07	·03	·03	·022
Total solid matter ...	45·5	40·04	30·24	30·24	43·68
Hardness, before boiling	22·75°	22·23°	20·4°	20·4°	23·2°
„ after „ (permanent)	3·85°	3·5°	2·2°	2·2°	5·2°

1, 2. It is satisfactory to find that the supply maintains its high character for organic purity and freedom from sewage-impregnation.

3, 4. Assuming the two samples to represent the public supply the results are very satisfactory and at no time before have such low figures for combined chlorine and nitrates been observed. The water in both is organically pure and there is no evidence of sewage-percolation. The figure for ammonia in No. 3 however requires explanation; such an amount is unusual.

5. The results are satisfactory both as to organic purity and absence of sewage-percolation.

Microscopical examination of deposit.

1, 2, Slight chalk; 3, chalky; 4, slight and unimportant; 5, slight traces of iron-oxide and vegetable fibres.

Another analysis, from the well at Whitehall. March, 1899.
Made and communicated by Dr. J. C. Thresh.
The greater part published in his *Examination of Waters and Water Supplies*, 1904.
Saline constituents, in parts per 100,000.

Ca. 13·3	Mg. 1·25	Na. —	CO_3. 14·8	SO_4. 3·3	Cl. 17·4	NO_3. 4·2	Probable combinations.
9·9	—	—	14·8	—	—	—	Calcium carbonate... 24·7
1·4	—	—	—	3·3	—	—	Calcium sulphate ... 4·7
1·35	—	—	—	—	—	4·2	Calcium nitrate ... 5·55
·65	—	—	—	—	1·15	—	Calcium chloride ... 1·8
—	1·25	—	—	—	3·7	—	Magnesium chloride 4·95
—	—	8·15	—	—	12·55	—	Sodium chloride ... 20·7
							Silica, etc ... ... 1·1

Total solid constituents dried at 180° C. 63·5

Organic ammonia (no free ammonia) ·002
Oxygen absorbed in 4 hours at 27° C. ·078

The following, made and communicated by Mr. C. Ekin, are presumably from the public supply. The figures are parts per million.

	Waterfall.	Granville Hotel.	Station.
Chlorine	206·	198·	206·
Ammonia	·08	0	·08
Nitrogen as nitrates (no nitrites)	8·23	8·89	9·22

The following sets of analyses are condensed from tables contributed by Mr. T. N. Ritson, late Engineer of Ramsgate. They deal with the years 1903—6.

Analyses of samples taken each month in 1903 gave the following results :—

Appearance and colour, clear and green-blue ; smell, none ; throughout.

Microscopic examination, slight or slight and unimportant throughout.

Chlorine in chlorides	varied from	13·31 in Dec. to 15·26 in Sept.
,, as salt	,, ,,	21·93 in Dec. to 25·15 in Sept.
Nitrogen in nitrates	,, ,,	·67 in Dec. to ·87 in Feb.
Ammonia	,, ,,	from none (generally) to ·0014 in Sept.
,, albuminoid	,, ,,	from ·0011 Oct. and Dec. to ·0019 March and May.
Oxygen absorbed in 15 minutes	,, ,,	trace only throughout.
,, ,, ,, 4 hours ...	,, ,,	from ·02 May to ·044 Oct.
Hardness before boiling (total)...	,, ,,	pretty constant 23·9-24·2.
,, after ,, (permanent)	,, ,,	,, ,, 6· to 6·5.
Total solid matter	,, ,,	50·47 July to 53·27 Nov.

A similar series taken in 1904 gave the following results :—

Appearance clear ; colour, green-blue ; smell, none ; throughout.

Microscopic examination of deposit, "slight (or very slight) and unimportant" in 11 months to "slight organic débris" in Feb.

Chlorine in chlorides	varied from	10·15 July to 12·81 Aug. and Dec.
,, as salt	,, ,,	16·73 July to 21·1 Aug. and Dec.
Nitrogen in nitrates	,, ,,	·46 Sept. next lowest ·66 Jan. ; highest ·84 Feb.
Ammonia	,, ,,	none very often to ·0005 Nov.
,, albuminoids	,, ,,	·0008 Sept. and Oct. to ·0017 Feb.
Oxygen absorbed in 15 minutes...	,, ,,	trace only throughout.
,, ,, ,, 4 hours ...	,, ,,	·0054 Sept. (next lowest ·028 Feb.) to ·052 July.
Hardness total	,, ,	22·9 Dec. and Sept., 23·9 Jan.
,, permanent	,, ,	5·3 Dec., Sept. and Oct. to 6·3 Jan.
Total solid matter	,, ,,	43·61 June to 51·24 Nov.

A similar series in 1905 gave the following results :—

Appearance clear (very clear Jan. and Feb.) ; colour green-blue ; smell none ; throughout.

Microscopic examination of deposit, slight and unimportant throughout.

Chlorine in chlorides	varied from	12·74 Feb. to 16·66 Oct.
,, as salt	,, ,,	20·99 Feb. to 27·45 ,,
Nitrogen in nitrates	,, ,,	·54 in Oct. to ·78 Jan. and Sept.
Ammonia	,, ,,	none generally to ·0006 in April.
,, albuminoid	,, ,,	·0006 Jan. to ·0021 May.
Oxygen absorbed in 15 minutes	,, ,,	trace only throughout.
,, ,, ,, 4 hours	,, ,,	·024 Jan. to ·064 in Sept.
Hardness before boiling (total)	,, ,,	22·9 June to 23·6 Sept.
,, after ,, (permanent)	,, ,,	5·3 Jan., June and Nov. to 5·8 May.
Total solid matter	,, ,,	49·35 June to 57·19 Sept.

Note.—Figures for the December sample not given.

A similar series in 1906 gave the following results :—

Appearance clear ; colour, green-blue ; smell none ; throughout.

Microscopic examination of deposit, slight in June, slight and unimportant in others.

Chlorine in chlorides	varied from	15·82 Jan. and Feb. to 21·35 Dec.
,, as salt	,, ,,	26·07 Jan. and Feb. to 35·18 Dec.
Nitrogen in nitrates	,, ,,	·69 in May to ·85 in Mar.
Ammonia	,, ,,	·0003 May, June, Aug., Sept., Nov., Dec. to ·0006 Jan. and Feb.
,, albuminoid	,, ,,	·0008 Jan., April and June to ·0019 March.
Oxygen absorbed in 15 minutes	,, ,,	trace only or traces throughout.
,, ,, ,, 4 hours	,, ,,	·022 Feb. to ·068 July.
Hardness before boiling (total)	,, ,,	26·6 June to 28·8 Sept.
,, after ,, (permanent)	,, ,,	·9 June to 10·9 Aug. and Sept.
Total solid matter	,, ,,	53·97 Jan. and June to 67·97 Sept.

A combination of the monthly analyses for the 4 years 1903—6.

Appearance clear (very clear Jan. and Feb. 1905) ; colour, green-blue ; smell none ; throughout.

Microscopic examination of deposit, slight (or very slight) and unimportant almost throughout (once "slight"). In Feb. 1904, there was "slight organic débris."

Chlorine in chlorides	varied from	10·15 July 1904 to 21·35 Dec. 1906.
,, as salts	,, ,,	16·73 July 1904 to 35·18 Dec. 1906.
Phosphoric acid as phosphates		None throughout.
Nitrogen in nitrates	,, ,,	·46 Sept. 1904 to ·87 in Feb. 1903.
Ammonia	,, ,,	none generally in 1903, 4, 5 to ·0014 Sept. 1903.
,, albuminoid	,, ,,	·0006 Jan. 1905 to ·0021 May 1905.
Oxygen absorbed in 15 minutes	,, ,,	trace only throughout (once "traces").
,, ,, ,, 4 hours	,, ,,	·0054 Sept. 1904* ; next lowest ·02, May 1903, highest ·068 July 1906.

* This figure is exceptional. Possibly should b ·054.

Hardness before boiling (total)...	„ „	22·9 Dec. and Sept. '04 and June '05 to 28·8 Sept. '06.
„ after „ (permanent)	„ „	5·3 Dec., Sept. and Oct. '04 and Jan., June and Nov. '05 to 10·9 Aug. and Sept. '06.
Total solid matter	„ „	43·61 June '04 to 67·97 Sept. '06.

Rochester.

Dr. T. Dunlop has referred to a water from here, without giving the precise site, which contains 35 grains of total solids to the gallon, of which 16 are calcium-carbonate and 8·5 sodium-chloride.

See also **Chatham.**

Saltwood. New Well (? for Hythe), bored to 45 feet deep. In Folkestone Beds. (See p. 187.)

Made (February, 1902) and communicated by Dr. J. C. Thresh. Mainly printed in his *Examination of Waters and Water Supplies*, 1904. Saline constituents, in parts per 100,000.

Ca. 4·95	Mg. ·3	Fe. trace	Na. —	CO_3. 4·5	SO_4. 3·7	Cl. 2·65	NO_3. 4·3	Probable combinations.	
3·	—	—	—	4·5	—	—	—	Calcium carbonate ...	7·5
1·55	—	—	—	—	3·7	—	—	Calcium sulphate ...	5·25
·4	—	—	—	—	—	·7	—	Calcium chloride ...	1·1
—	·3	—	—	—	—	·9	—	Magnesium chloride..	1·2
—	—	—	·7	—	—	1·05	—	Sodium chloride ...	1·75
—	—	—	2·1	—	—	—	4·3	Sodium (and potassium) nitrate ...	6·4
								Silica, etc.	1·9

Total solid constituents dried at 180° C. 25·1

Free ammonia...	·032
Organic ammonia	·007
Oxygen absorbed in 4 hours at 27° C.	·08

Sandwich. Market Pump.

By G. W. Wigner, *The Water Supply of Sea-side Watering-places*, 1878, pp. 34, 35, 61. In grains per gallon.

This is a striking instance of the evil supplies that were in use several years ago.—W. W.

No public supply at the time, except from pumps and the Delf Stream, which runs through the town, the analysis of which is much better than this.

Total solid matter	103·8
Loss on ignition after deducting combined carbonic acid	11·3
Iron, traces	
Chlorine calculated as chloride of sodium...	29·07
Nitrogen as ammonia	·0029
„ „ albumenoid ammonia	·027
„ „ nitrates	4·13
„ „ nitrites	·004
Total nitrogen in these four forms	4·1639
Oxygen absorbed by organic matter	·054

Hardness, Clark's scale, before boiling 36·5°, after boiling 19°.

Colour objectionable, a dirty pale yellow; fairly free from unpleasant smell or taste. Microscopic examination eminently unsatisfactory. "The residue left on evaporating a few drops . . . was full of animal matter, a good deal evidently decomposing animal remains and muscular fibre . . . . it would be much more appropriate to call the liquid from this pump sewage rather than water."

He adds that it "appears, on the whole, to claim pre-eminence as the worst of these private waters (of seven places where there was no real public supply) . . . however valuable this fluid might be as a liquid manure, and it would be impossible to deny that it has a certain value in this respect" it should not be used as water.

It is satisfactory to say that the town has now an excellent supply, from a well at Woodnesborough. (See pp. 216, 217, 352.)

Sevenoaks.

1. WATER CO. (See p. 191.) From Kentish Rag.

Made by Dr. J. S. TEW, May, 1898. Communicated by Dr. F. PARSONS.
Sample taken from a scullery-tap in Camden Road, May 27th.

Chemical analysis, in parts per 100,000.

Albumenoid ammonia (no free ammonia)	·002
Oxygen absorbed in 4 hours at 80° F. ...	·011
Total solids	29·
Loss on ignition	8·
Chlorine	2·1
Nitrogen as nitrates (none as nitrites) ...	·042

Hardness 17°.

An excellent water for drinking and domestic purposes, possessing a high degree of organic purity.

Bacteriological examination.

Sample collected, from same source, in bottles sterilised for two hours at 150° C. packed in ice and examination commenced the same day.

One cubic centimetre gave an average of 57 bacteria capable of development in gelatine at 22° C. in 48 hours. The proportion of liquefying organisms was 1 to 45.

Special search was made for the typhoid and coli bacilli by the usual methods with a negative result.

The above results are satisfactory and indicate that the water, from a bacteriological point of view, is pure and uncontaminated.

Another analysis, made (April, 1906), and communicated by Dr. J. C. THRESH, is as follows.

Saline constituents, in parts per 100,000.

Ca.	Mg.	Na.	CO_3.	SO_4.	Cl.	NO_3.	Probable combinations.	
8·2	·2	—	10·1	1·9	2·3	1·75		
6·7	—	—	10·1	—	—	—	Calcium carbonate...	16·8
·8	—	—	—	1·9	—	—	Calcium sulphate ...	2·7
·7	—	—	—	—	1·25	—	Calcium chloride ...	1·95
—	·2	—	—	—	·6	—	Magnesium chloride	·8
—	—	·25	—	—	·45	—	Sodium chloride ...	·7
—	—	·55	—	—	—	1·75	Sodium nitrate ...	2·3
							Silica, etc.	·25
							Total solid constituents dried at 180° C.	25·5

Organic ammonia (no free ammonia) ·002
Oxygen absorbed in 4 hours at 27° C. ·01

See also **Kemsing.** (p. 322.)

2. Mr. W. Spottiswoode's Well, 60 feet deep, August, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 105. Given as an example of a polluted water from a deep well in the Lower Greensand.

Slightly turbid. Palatable.

Total solid impurity...	38·76	Parts per 100,000.
Organic carbon	·447	
Organic nitrogen (no ammonia) ...	·072	
Nitrogen as nitrates and nitrites	·252	
Total combined nitrogen	·324	
Chlorine	5·9	

Hardness, temporary 7·2, permanent 13·4; total 20·6.

3. Spring in Railway-tunnel, February 21st, 1873.

This is not really a spring, that is to say the water is got artificially and at considerable depth, not at or close to the surface of the ground.—W. W.

Rivers Pollution Commission. Sixth Report, 1874, p. 121. Repeated pp. 292, 293.

Slightly turbid. Palatable. Temperature 9° C.

Total solid impurity...	34·36	Parts per 100,000.
Organic carbon	·015	
Organic nitrogen (no ammonia) ...	·002	
Nitrogen as nitrates and nitrites	·416	
Total combined nitrogen	·418	
Chlorine	2·1	

Hardness, temporary 13·7, permanent 5·7; total 19·4.

This water is presumably that which is taken for the public supply. —W.W.

Sheerness. (See pp. 192, 194.)

1. Old Well in Dockyard, 450 feet deep. 2. Well at Waterworks, 384 feet deep. Both April 21st, 1873.

Rivers Pollution Commission. Sixth Report, 1874, p. 104.

In both temperature 16·7° C. (or 62° F.) Both clear and palatable. In parts per 100,000.

	1.	2.
Total solid impurity	61·1	56·8
Organic carbon	·133	·117
Organic nitrogen	—	·021
Ammonia	·19	·1
Nitrogen as nitrates and nitrites	0	·027
Total combined nitrogen ...	—	·13
Chlorine	9·1	5·8

1. Hardness, temporary 4·5, permanent 3·6; total 8·1.
2. „ „ 10·8 „ 4·7; „ 15·5.

3. New Ordnance Well,

By Dr. F. A. De Chaumont, 13th June, 1878.

Hardness, fixed	1·4°
„ temporary or removable	4·9°
Total	6·3° of Clark's scale.

	Grains per gallon.
Volatile matter (by incineration)	1·05
Chlorine...	8·9776
Sodium (combined with above)	5·8282
Calcium carbonate	3·27
Fixed hard salts (estimated as calcium carbonate)	1·4
Sulphuric acid	22·1742
Alkaline carbonates, etc.	
Silica, alumina, etc.	
	42·7

4. Public Supply. Sample drawn from the Main.

G. W. Wigner, *The Water Supply of Sea-side Watering-places*, 1878, p. 22. In grains per gallon.

Total solid matter	44·6
Loss on ignition after deducting combined carbonic acid	4·8
Iron, traces.	
Chlorine calculated as chloride of sodium...	7·13
Nitrogen as ammonia	·002
„ „ albumenoid ammonia	·0009
„ „ nitrates	·832
„ „ nitrites	·017
Total nitrogen in these four forms	·8519
Oxygen absorbed by organic matter	·0304

Hardness, Clark's scale, before boiling 10·6°, after boiling ·2°.

Slightly turbid; free from objectionable taste or smell. Microscopic examination quite satisfactory. "The only bad feature . . is the amount of nitrogen in the form of nitrates."

Another sample, from the Surveyor, drawn a fortnight later gave results almost identical. The water is therefore uniform in quality. A good water.

The following table is from Dr. G. S. Buchanan's *Report to the Local Government Board on Sheerness*, 1905, p. 20. In parts per 100,000.

Well.	Analysed by.	Total solids.	Hardness. Total.	Hardness. Fixed.	Chlorine.	Free ammonia.	Albumenoid ammonia.	Oxygen absorbed.	Remarks.
Garrison Well	War Department, 1877	61·	9·	2·	12·82	0	0	—	Clear. Small sediment of sand. Trace of iron.
Garrison Well	War Department, 1900	59·	8·	6·	13·5	·074	·005	·0296 (15 min. at 80°)	Clear. Small deposit of sand.
Navy "New Well"	Haslar Laboratory, May, 1900	63·	6·6	2·2	7·6	·15	·08	0 (3 hours)	Slight turbidity. Scarcely perceptible sediment.
Town Supply	Haslar Laboratory, May, 1900	72·	17·4	7·4	6·2	·084	·034	·024 (3 hours)	Slight turbidity. No sediment.
Town Supply from service-tank	J. Muter, July, 1904	60·	11·7	0	6·43	·04	·004	·059 (4 hours)	Alkaline reaction. Contained 17·5 parts of sodium-carbonate.
Sheppey Union	War Department, 1900	63·5	6·	5·5	7·6	0	0	·006 (15 min. at 80°)	Clear. Small sediment of sand and vegetable débris.

Southborough. Public Supply. (See p. 199.)

From Trial-bore at Modest Corner (abandoned). In Hastings Beds.
By M. A. ADAMS, Public Analyst for Kent. Communicated by Dr. F. PARSONS.

Mineral analysis, in grains per gallon (? March, April, 1896).

Soda	15·963	Sodium chloride ...	4·944
Sodium	1·944	Sodium sulphate ...	14·981
Lime	·609	Sodium nitrate ...	2·767
Magnesia	·401	Sodium carbonate ...	14·383
Sulphuric acid ...	8·44	Calcium carbonate ...	1·088
Chlorine	3·	Magnesium carbonate	·842
Nitric acid	1·758		
Carbonic acid ...	6·89		
Iron oxide	·028	Iron oxide	·028
Silica	·574	Silica	·574
Total	39·607	Total	39·607

Suspended matter wholly inorganic 1·47.

From bore-hole, March 12th, 1896.

Total solids (excess)... ...	42·7	Grains per gallon.
Loss on ignition	2·4	
Chlorine	3·	
Nitrogen as nitrates... ...	·45	
Oxygen absorbed in ¼ hour	·007	
" " " 4 hours	·012	
Phosphoric acid, trace.		
Free ammonia (large excess)	·5	Parts per million.
Albumenoid ammonia ...	·04	

Appearance in 2-foot tube, opaque yellowish-green (excess).

"From a sanitary point of view I have to remark upon the large amount of solid dissolved matter, the large excess of free ammonia and the opaque yellowish-green condition of the water. The excess of free ammonia, in my belief, is due to a partial reduction of the nitrates and is in no way connected with organic pollution. The opacity is probably the result of disturbance inseparably . . connected with the boring of the well. So that everything considered I am able to report favourably as to its wholesomeness so far as freedom from organic pollution is concerned."

"As respects its mineral composition it is not at all an ordinary water. Its main constituents are sulphate and carbonate of soda in large quantities [and] about double the usual amount of chloride of sodium, nitrate of soda and carbonate of lime [?] . . The water must be regarded in the light of an alkaline mineral water possessing medicinal properties."

"From a domestic point of view it is very soft and must prove to be an excellent water for all washing and cleansing purposes."

"For bathing purposes it is likely to be very useful in suitable cases."

"The sanitary analysis should be repeated after the well has had time to settle down into ordinary permanent condition."

Another analysis, of water from a depth of 370 feet, made by R. A. CRIPPS in June, 1896. Also communicated by Dr. F. PARSONS.

Total solids	39·5	Grains per gallon.]
Chlorine	2·3	
Ammonia	·0147	
Albumenoid ammonia	·0007	
Nitrogen as nitrates (none as nitrites) ...	·02	
Oxygen absorbed in 5 minutes...	·0215	
" " " 3 hours	·0492	
Iron, traces.		
Alkalinity, calculated as bicarbonate of soda	41·7	

Temporary hardness 1·1°, permanent ·9°; total 2°.
No smell.

"This water is of fairly good quality. It is free from organic pollution . . but is distinctly alkaline."

"The water may be drunk with safety, although not of that high standard of quality which is desirable."

Analysis of water, from a well 103 feet deep, into sandstone, at Upper Hayesden (No. 1).

Made by Prof. P. F. **Frankland**, January, 1901. Communicated by Dr. F. **Parsons**. In parts per 100,000.

Sample collected on December 31st, 1900, under the conditions in which it would be delivered from the well in regular working.

For the purpose of comparison the second column of figures shows the result of an analysis of water from the trial-bore, 330 feet deep, into Ashdown Sand, made by Sir E. **Frankland** in January, 1899.

	Well.	Trial-bore.
Total solid matters	31·17	42·68
Organic carbon	·061	·073
Organic nitrogen...	·009	·018
Ammonia	·034	·024
Nitrogen as nitrates and nitrites	trace	·148
Total combined nitrogen ...	·037	·179
Chlorine	3·2	2·
Carbonate of soda	6·49	26·5
Iron...	—	·075

Hardness (well) temporary 4·5, permanent 3·5; total 8.

Well. Very turbid, giving thick ferruginous deposit (clay and iron-oxide). Analysis made on clear liquid after settlement. Palatable.

Bore. Turbid.

Of the well-water Prof. **Frankland** says that it is of a high degree of organic purity and of excellent quality for drinking and all domestic purposes. The composition differs materially from that from the trial-bore, which may be accounted for through the previous sample having been taken from the bore, whilst the other is a mixture of the water from the well, the headings, and the deep bore.

Dr. **Parsons** adds that the water is to be filtered, to remove the suspended clay and the iron-oxide.

Analysis made (June, 1906) and communicated by Dr. J. C. **Thresh**, from boring at Hayesden.

Saline constituents, in parts per 100,000.

Ca. 2·	Mg. ·6	Na. —	CO_3. 6·3	SO_4. 2·	Cl. 3·4	NO_3. 1·5	Probable combinations.
2·	—	—	3·	—	—	—	Calcium carbonate ... 5·
—	·6	—	1·5	—	—	—	Magnesium carbonate 2·1
—	—	1·4	1·8	—	—	—	Sodium carbonate ... 3·2
—	—	1·	—	2·	—	—	Sodium sulphate ... 3·
—	—	2·2	—	—	3·4	—	Sodium chloride ... 5·6
—	—	·55	—	—	—	1·5	Sodium nitrate ... 2·05
							Silica, etc. ... ... 1·55

Total solid constituents dried at 180° C. 22·5

Free ammonia	·002
Organic ammonia	·003
Oxygen absorbed in 4 hours at 27° C.	·009

Staplehurst. TORONTO HOUSE. On Weald Clay.

September, 1872.

Rivers Pollution Commission. Sixth Report, 1874, p. 82.
In parts per 100,000.

Total solid impurity	381·1
Organic carbon	·202
Organic nitrogen	·048
Ammonia	·16
Nitrogen as nitrates and nitrites	·064
Total combined nitrogen ...	·244
Chlorine	82·5

Hardness, temporary 8, permanent 4; total 12.
Bad odour. Turbid. Shallow well.

Strood. WATERWORKS. Wells in Chalk. (See pp. 202—204.)

The sample seems to have been taken from the Reservoir.

1881.

Communicated by Mr. W. BANKS, City Surveyor, Rochester.

The water was bright and sparkling, free from suspended matter and smell. On evaporation it gave a residue of 32·9 grains per gallon, which, on gentle ignition, was reduced without blackening to 28·9 grains. This solid matter was found to consist as follows :—

Chlorine	3·3
Sulphuric acid	·74
Nitric acid	·89
Carbonic acid	9·18
Soda	2·92
Magnesia	·61
Iron-oxide	·05
Silica	1·24
Lime	11·79
	30·72
Deduct oxygen for chlorine	·74
	29·98

These may be supposed to exist in the following states of combination :—

Sodium chloride ...	5·44	(Chlorine 3·3)
„ sulphate ...	·09	
Calcium sulphate ...	1·17	
„ nitrate ..	1·36	
„ carbonate ...	19·35	
Magnesium carbonate	1·28	
Ferric oxide	·05	
Silica	1·24	
	29·98	

Free ammonia, none. Albumenoid ammonia ·2 parts per million.

An ordinary Chalk-water, pure and good, well suited for dietetic use. The organic matter is especially low. The oxygen consumed per gallon in 15 minutes was ·0148 grain, and in 4 hours ·0532. There was a trace only of phosphoric acid. The water is very hard.

Hardness, total 19·1°, permanent 3·7°.

Appearance in 2-foot tube, pale bluish-green and clear.

Swanscombe.

1. Broomfield Road. March, 1900.

Made and communicated by Dr. J. C. Thresh.

Well in Chalk throughout. Said to be 105 feet deep and to contain only 3 feet of water. About 200 feet above Ordnance Datum. A polluted water.

Saline constituents, in parts per 100,000.

Ca. 14·05	Mg. ·7	K. ·6	Na. 2·5	CO_3. 16·5	SO_4. 3·35	Cl. 5·	NO_3. 7·9	Probable combinations.	
11·	—	—	—	16·5	—	—	—	Calcium carbonate ...	27·5
1·4	—	—	—	—	3·35	—	—	Calcium sulphate ...	4·75
1·65	—	—	—	—	—	2·9	—	Calcium chloride ...	4·55
—	·7	—	—	—	—	2·05	—	Magnesium chloride	2·75
—	—	·6	—	—	—	—	·95	Potassium nitrate ...	1·55
—	—	—	2·5	—	—	—	6·95	Sodium nitrate ...	9·45
								Silica, phosphates, etc., organic matter	3·35

Total solid constituents dried at 180° C. 53·9

Free ammonia ... ... ·002
Organic ammonia ... ... ·022
Oxygen absorbed in 4 hours at 27° C. ·114

2. Eckman's Northfleet Paper Works. January, 1903.

From Chalk.

Made and communicated by Dr. J. C. Thresh.

Saline constituents, in parts per 100,000.

Ca. 10·9	Mg. ·9	Fe. ·15	Na. —	CO_3. 18·1	SO_4. ·9	Cl. 2·5	NO_3. ·4	Probable combinations.	
10·9	—	—	—	16·35	—	—	—	Calcium carbonate ...	27·25
—	·7	—	—	1·75	—	—	—	Magnesium carbonate	2·45
—	·2	—	—	—	·8	—	—	Magnesium sulphate	1·
—	—	—	1·6	—	—	2·5	—	Sodium chloride ...	4·1
—	—	—	·2	—	—	—	·4	Sodium nitrate ...	·6
								Traces of iron, silica, etc.	2·

Total solid constituents dried at 180° C. 37·4

There is an odour of sulphuretted hydrogen when the well is uncovered.

3. Sample from relief-valve on pump from Barnfield.

November, 1903.

By E. J. Read. Communicated by Mr. C. Beadle.

Total solids	42·21	Grains per gallon.
Suspended matter (probably chalk) ...	10·65	
Silica	1·15	
Iron and alumina...	·26	
Calcium carbonate	17·25	
Calcium sulphate...	1·43	
Magnesium sulphate	·69	
Magnesium chloride	·92	
Alkali-chlorides	3·78	
Oxygen consumed, 15 minutes at 27° C.	·015	Parts per 100,000.
,, ,, 4 hours ,, ,,	·028	
Albumenoid ammonia, no free ammonia	·016	
Chlorine	2·59	Grains per gallon.
Nitrates as nitrogen	·52	

Hardness, temporary 16·8°; permanent 5·2°.

The somewhat high oxygen consumed and albumenoid ammonia indicate that it is not a desirable water for drinking purposes. They are apparently due to certain forms of plant, related to the *algæ* and probably harmless.

Thanington. CANTERBURY WATERWORKS. (See p. 206.)

By D. CAMPBELL. From sample taken from No. 2 bore-hole, October 24th, 1868, "after about 800,000 gallons of water per 24 hours had been pumped from the bore-hole for 120 hours." Supply from the Chalk.

Normal temperature of the water 51° F.

Report to the Directors of the Company, 1869. Reprinted in S. C. HOMERSHAM'S *Report on Water Supply* (to Wimbledon Local Board), 1877, pp. 32, 33; *Chemical Report*, pp. 37-39. Also printed elsewhere.

Analysis of the evaporated residuum of the water, both before and after softening, in grains per gallon.

	Before softening.	After softening.
Carbonate of lime	15·96	1·39
Sulphate of lime	·08	·07
Nitrate of lime	2·06	2·04
Magnesia, probably as silicate... ...	·29	·27
*Chlorides of sodium and of potassium	3·45	3·41
Silica	·96	·4
Oxide of iron	·16	—
Volatile matter	·96	·8
Total solid residue	23·92	8·38

* Elsewhere this is divided as 3· of the first and ·45 of the second (*Proc. Inst. C.E.*, vol. xlvii., ?p. 160).

Sensible hardness before softening 14·9°, latent 3·65°; total 18·55°
" " after " 3·8°, " ·0 ; " 3·8°

Gases in the water.	Before softening.	After softening.
Oxygen	2·21	2·09
Nitrogen	5·9	5·9
Carbonic acid, in combination, not free	7·87	·37

"The original water, when softened, becomes very soft, and the good qualities of the original water remaining unaltered, is thereby rendered a most desirable water for culinary, drinking, washing, and manufacturing purposes . . . it is perfectly bright, colourless, inodorous, wholesome and pleasant to drink."

CANTERBURY. Public supply (presumably from same source).

In grains per gallon.

Royal Commission on Water Supply. Appendix, p. 77. Fol. *Lond.*, 1869.

Bright and colourless in glass tube 2 feet long.

Solid matter	21·85
Organic and other volatile matter	1·
Oxygen required to oxidise organic and other matter	·007
Ammonia	·02

Hardness, before boiling 18°, after boiling 4·5°.

Another analysis by Sir E. FRANKLAND, October 29th, 1870.

1. *Rivers Pollution Commission. Sixth Report*, 1874, p. 99, leaving well.
2. After softening. From S. C. HOMERSHAM'S *Report on Water Supply* (to Wimbledon Local Board), 1877, p. 45.

Water clear and palatable. Temperature 10·8° C. (51·4° F.).

Results in parts per 100,000. In the latter publication referred to the results are also given in grains per gallon.

	1.	2.
Total solid impurity	33·6	11·94
Organic carbon	·012	0
Organic nitrogen (no ammonia) ...	·012	0
Nitrogen as nitrates and nitrites	·426	·431
Total combined nitrogen	·438	·438
Chlorine	2·1	2·1

1. Hardness, temporary 22·1, permanent 4·2; total 26·3.
2. Hardness, 4·86.

Tunbridge *or* Tonbridge.

1. HILDENBOROUGH. Mr. Kingscote's.

Well 97 feet in clay. Water, from rock, rose to within from 10 to 15 feet from the surface.

Analysis made by Mr. B. DYER, 1877 (or earlier ?). Results in grains per gallon.

Oxide of iron and alumina	trace
Sulphate of lime	6·65
Sulphate of magnesia...	1·35
Sulphate of soda	45·16
Chloride of sodium	33·22
Alkaline carbonates, nitrates and organic matter	24·08
Insoluble siliceous matter and clay	1·96
	112·42

Free ammonia ... ·004
Organic ammonia ·007

Solid matter since reduced to 60 grains per gallon, including only 25 of sulphate of soda. The salts vary much at various times. The water "is organically pure and at its worst I suppose it will only have a mildly aperient effect." As Mr. DYER'S lotter (to Mr. C. E. Hawkins) says that Mr. Kingscote intends to use the water, it would be interesting to know the result.

Mr. DYER also adds that he "has found by making two or three approximate analyses at different stages of pumping that both the total solid matters and the proportion of sulphate of soda undergo remarkable fluctuations," one analysis showing the sulphate of soda reduced to half its original quantity, whilst in another it considerably exceeded the original. He also says that the brackish taste has disappeared.

2. SCHOOL. April 1878.

From Wells. Two samples. *a* Pump Room and *b* Fountain.

Made by Mr. M. A. ADAMS.

		a	*b*
Solids...	in grains per gallon	38·5	39
Chlorine	,, ,, ,,	5·8	5·9
Ammonia albuminoid (none "free"),	in parts per million	·06	·05

Hardness, Clark's scale, 22° and 21°, total; 10·5° and 10°, permanent.

Though they might pass muster when compared with the average of well-water, they are not as pure as they should be.

In comparison with analyses of Tonbridge Water Works water, done at the same time, Mr. Adams says that these samples "contain far too much solid matter, and what is more significant, too much Chlorine and Albuminoid Ammonia," that is taking the Water Company's water as a fair standard of local purity. "I should advise that these waters should not be used for drinking or other similar domestic purposes."

The well here, which once supplied the School, has been disused for a long time. It is believed to be just in front of the School-house.

3. Water Company. Shallow Well in River Gravel. (See p. 208.)

By Prof. Wanklyn. October 1876.

Solids in grains per gallon...	22·
Chlorine " " "	2·4
Ammonia, free, in parts per million ...	·04
" albuminoid " " " ...	·04

Hardness 16°.
"Remarkably free from organic matters."

By Mr. W. R. Loftus. February 1878.

Specific gravity 1000·36

Inorganic matter	25·12	Grains per gallon.
Organic "	1·24	
Total residue	26·36	
Sulphate of lime	4·15	
Carbonate of lime	12·65	
Carbonate of magnesia ...	only traces	

Hardness 17°, after boiling 3·3°.
"No exception can be taken to it on the score of purity, as it is above the average in this respect."

Made by Messrs. Allen and Hanbury. September 1891.

Colour in two-foot tube pale plue clear.
Suspended matter, and taste and smell when heated to 100° F. none.
Hardness before boiling 18°, after boiling 8° (Clark's scale).

Total solid matter	30·8	Grains per gallon.
Loss on ignition	2·1	
Total mineral matter	27·7	
Chlorine, equal to chloride of sodium ...	4·91	
Phosphoric acid	trace	
Nitrogen as ammonia	·0024	
" " albuminoid ammonia	·0021	
" " nitrates	·4	

Oxygen absorbed by organic matter from solution of permanganate of potash at 80 F. in 2 minutes, none; in 4 minutes, ·0107.

Valuation (Wigner's scale).

Values below 35 indicate first class water, and samples with a value above 75 are unfit for drinking.

The London Waters generally average a value of about 30 and the best public supplies 10 to 15.

The valuation of this sample is 27. Therefore it is a first class water.

A very good water. No trace of contamination with animal organic matter.

Made (December, 1897) and communicated by Dr. J. C. **Thresh.**
Saline constituents, in parts per 100,000.

Ca.	Mg.	Na.	CO_3.	SO_4.	Cl.	NO_3.	Probable combinations.	
8·7	·8	—	10·3	7·3	3·7	1·3		
6·9	—	—	10·3	—	—	—	Calcium carbonate..	17·2
1·7	—	—	—	4·1	—	—	Calcium sulphate....	5·8
—	·8	—	—	3·2	—	—	Magnesium sulphate	4·
—	—	2·4	—	—	3·7	—	Sodium chloride ...	6·1
—	—	·4	—	—	—	1·3	Sodium nitrate ...	1·7
							Silica, etc.	2·2
							Total solid constituents dried at 180° C.	37·

Free ammonia	·002
Organic ammonia	·003
Oxygen absorbed in 4 hours at 27° C.	·017

a Analysis, of a sample taken February 15th, 1900, by Dr. J. S. Tew.
Communicated by Dr. F. Parsons.

b. By Dr. Tew. October 15, 1898, *Tonbridge Free Press*, November 12, 1898.

	a	*b*
Albumenoid ammonia (no free ammonia) ...	·002	·006
Oxygen absorbed in 4 hours at 80° F. ...	·005	·019
Total solids	39·	32·
Loss on ignition	12·	5·
Chlorine	3·7	3·7
Nitrogen as nitrates (none as nitrites) ...	·376	·237
Alkalinity as Ca CO_3	18·7	15·5

In parts per 100,000.

Hardness 19·4 and 17·38, permanent 3·1 and 3·25.

"In both the water was clear and bright. There was no sediment and no smell."

An older analysis, said to be from a deeper well in Hastings Sand.
February 21st, 1873.
Rivers Pollution Commission. Sixth Report, 1874, p. 97.
Clear and palatable. Temperature 9·6° C.

Total solid impurity	34·76	Parts per 100,000.
Organic carbon	·036	
Organic nitrogen (no ammonia)...	·006	
Nitrogen as nitrates and nitrites	·501	
Total combined nitrogen ...	·507	
Chlorine	2·9	

Hardness, temporary 15·1, permanent 7 ; total 22·1.

Mr. Simmond's Brewery, near Tunbridge. February, 1890.

By Dr. G. H. Ogston.

Total solid matter ...	65·73	Grains per gallon.
Carbonate of soda ...	46·4	
Chloride of sodium ...	17·72	
Chloride of calcium ...	·71	
Chloride of magnesium	·04	
Ammonia, free ...	·015	Parts per million.
Ammonia, organic ...	·05	

Oxygen required to oxydise organic matter ·015. No nitrates.

The water is bright and colourless. Hardness none.

"One of those remarkable waters sometimes met with in which the lime originally present has been replaced by soda and so we have carbonate of soda instead of carbonate of lime in solution. The only question in regard to the fitness of this water for a domestic supply, its organic purity being satisfactory, is whether the . . . carbonate of soda would be an objection. In my own opinion it would not. . . For manufacturing purposes and for washing no better water could be desired as there would be no deposit in boilers and the minimum consumption of soap would suffice."

Tunbridge Wells, *see* **Pembury**, pp. 331, 332.

Walmer. DEAL WATERWORKS. (See p. 212.) Well 115 feet.

Three analyses. In first and second water clear, in third slightly turbid, in all palatable. Temperature, in second, 11·3° C. Water from the Chalk. *Rivers Pollution Commission. Sixth Report*, 1874, p. 99.

In parts per 100,000.

	July 24, 1869.	March 1, 1873.	August 28, 1873.
Total solid impurity	33·2	34·06	31·74
Organic carbon	·032	·05	·056
Organic nitrogen...	·013	·007	·024
Ammonia	—	·002	·004
Nitrogen as nitrates and nitrites	·698	·803	·702
Total combined nitrogen ...	·711	·812	·729
Chlorine	2·8	3·	2·9
Hardness, temporary	20·4	18·2	20·2
„ permanent	5·9	5·4	6·1
„ total	26·3	23·6	26·3

Three analyses, by G. W. WIGNER, *The Water Supply of Sea-side Watering-places*, 1878, pp. 35-37.

1. Sample received from the Surveyor. 2. Taken from a main tap at an hotel near the station. 3. Taken from the reservoir.

	1.	2.	3.
Total solid matter	25·4	26·6	27·4
Loss on ignition after deducting combined carbonic acid	4·7	1·18	2·87
Iron	traces	—	—
Chlorine calculated as chloride of sodium ...	3·51	3·35	3·51
Nitrogen as ammonia	·0015	·0037	·0049
„ „ albuminoid ammonia	·0029	·0026	·0023
„ „ nitrates	·535	·374	·346
„ „ nitrites	·008	·004	·004
Total nitrogen in these four forms	·5474	·3843	·3572
Oxygen absorbed by organic matter... ...	·0144	·008	·02

Hardness, Clark's scale, before boiling, 15·1°, 14·7° and 15°, after boiling 3·5°, 4·2°, and 4°.

1. Water yellowish, from traces of suspended matter. Free from objectionable smell. Taste slightly chalky. Microscopic examination satisfactory.

2, 3. Slight smell and when warmed a taste of chalk, but free from the yellowish colour. Microscopic examination satisfactory.

3. Traces of suspended matter.

"These three samples are very accordant in composition, and are all good."

By A. HARDEN. From the *Report of the Medical Officer of Health* for 1901. Communicated by Dr. F. PARSONS.

From stand-pipe at Park Street. Sample clear and free from smell. No suspended matter.

Analytical data, in parts per 100,000.

Dissolved solids...	33·15
Chlorine ...	2·6
Alkalinity, expressed as calcium carbonate	21·5
Free and saline ammonia	·0006
Albuminoid ammonia ...	·0016
Nitrogen as nitrates (none as nitrites)	·63
Oxygen absorbed from permanganate at 80° F. in 4 hours	none

Permanent hardness 5.

"The sample is characterised by the extremely small amount of unoxidised organic matter which it contains. . . A very excellent characteristic of the water is its great constancy of composition from quarter to quarter and from year to year. There is no chemical evidence of pollution from dangerous sources."

Dr. A. MACFADYEN adds the following bacteriologic note:—"This sample of water contained, per cubic centimetre, 88 organisms growing on gelatin at a temperature of 22° C. The *Bacillus Coli communis* was not found in 6 cubic centimetres of the sample. There was therefore no evidence of pollution of intestinal origin."

Westerham. METROPOLITAN WATER BOARD. (See p. 212.)

In parts per 100,000. From the former Kent Water Co.

	1. Westerham.	Westerham Hill.
Total solid matters ...	25·	28·74
Organic carbon ...	·025	·023
Organic nitrogen ...	·008	·003
Nitrogen as nitrates and nitrites (no ammonia)	·187	·701
Total combined nitrogen ...	·195	·704
Chlorine ...	1·8	1·

Hardness (1), temporary 15, permanent 3·3; total 18·3.
„ (2), „ 17·5, „ 4·6; „ 22·1.

Westgate. Public supply. (From the Chalk. See p. 212.)

By G. W. WIGNER, *The Water Supply of Sea-side Watering-places*, 1878. pp. 25, 26. In grains per gallon.

Sample drawn from a main, July 17th, 1877.

Total solid matter ...	33·5
Loss on ignition after deducting combined carbonic acid	3·5
Lead very minute traces. Iron slight traces.	
Chlorine calculated as chloride of sodium...	6·78
Nitrogen as ammonia ...	·0005
„ „ albumenoid ammonia ...	·0012
„ „ nitrates ...	·79
„ „ nitrites ...	·02
Total nitrogen in these four forms ...	·8117
Oxygen absorbed by organic matter	·0288

Hardness, Clark's scale, before boiling 20°, after boiling 4·8°.

"The principal variations from the results obtained last year are that the total solids have increased by 4 grs., while the ammonia and albuminoid ammonia have both decreased." The water was pale blue and free from suspended matter. Microscopic examination did not show any organic matter. A very pure water.

? **West Wickham** or **Keston.** SPARROWSDEN COTTAGES. Near the source of the West Wickham Bourne.

By Dr. A. J. BERNAYS. Collected October 7th, 1878. From MSS. Papers of Sir J. PRESTWICH. In grains per gallon.

Potassoxide	·24	[Total 22·44.]
Sodium-oxide	·67	
Calcium-oxide ...	8·81	
Magnesia	1·15	
Chlorine	·85	
Carbon-dioxide ...	6·59	
Sulphur-trioxide ...	1·98	
Nitrogen-pentoxide ...	1·4	
Silica	1·15	

These are probably combined as follows:—

Sodium-chloride ...	1·27	Total 22·65.
Potassium-sulphate ...	·45	
Calcium-sulphate ...	3·01	
Calcium-chloride ...	·12	
Calcium-carbonate ...	13·41	
Magnesium-carbonate	1·32	
Magnesium-nitrate ...	1·92	
Silica	1·15	
Free ammonia... ...	·002	
Albumenoid ammonia	·002	
Nitrogen (oxydised)...	·364	

Total residue 23·58.

Hardness before boiling 18, after boiling 3.

Well 50 feet deep, through Tertiary sand, just touching the Chalk.

Water-level varies considerably, with the season. In wet years when the bourne flowed it rose within a few feet of the surface.

A slightly earlier analysis, from a sample taken March 2nd, 1878, gave Dr. BERNAYS a slightly different result, the figures being as follows (Sir J. Prestwich's MSS. Papers):—

	Grains per gallon.	Parts per 100,000.
Total solid matter	22·08	31·54
Chlorine	·98	1·4
Ammonia, free	·0032	·0046
Ammonia, albumenoid	·0028	·004
Organic carbon	·031	·045
Organic nitrogen	·008	·012
Nitrogen as nitrates and nitrites	·336	·48

Hardness 16·74, permanent 2·74.

Willesborough, *see* **Hinxhill,** p. 320.

Wingham. MARGATE WATERWORKS. (From the Chalk. See p. 215.)

Communicated by Mr. E A. BORG. Made by S. HARVEY. April, 1907 In grains per gallon.

Appearance, clear; colour, green-blue; smell, none.

Chlorine in Chlorides (equal to salt 2·54)	1·54
Nitrogen in Nitrates	·41
Ammonia, albuminoid (none free)	·0006
Oxygen absorbed in 15 minutes	trace only
„ „ „ 4 hours	·014
Total solid matter	23·52

Hardness before boiling (total) 18·9°, after boiling (permanent) 2·8°.

Microscopical examination of deposit. Slight and unimportant, satisfactory.

Organically very pure and free from sewage-percolation.

Bacteriological examination. May, 1908. Made by
Prof. A. G. R Foulerton.

Physical. Naked eye appearances. Clear and bright; no appreciable colour; no obvious suspended matter; no definite deposit after standing 24 hours.

Reaction neutral. Temperature, 16° C.

Bacteriological. Quantitative examination of micro-organisms. One cubic centimetre contained 10 bacteria capable of growth on gelatine within 72 hours incubation at 22° C. Two cubic centimetres, incubated in Agar-plates for 24 hours at 37° C., yielded the growth of only one micro-organism.

Qualitative examination. 8 cubic centimetres, after 48 hours incubation at 37° C., in various fluid media, gave no growth.

Remarks. As in previous samples there is no evidence of organic pollution.

Woodnesborough. Sandwich and Eastry Joint Water Board. (From the Chalk. See p. 216.)

Made and communicated by C. Ekin. Sample from the rising main at the works.

Total solids	468	Parts per million.
Chlorine	32	
Nitrogen as nitrates (no nitrites or ammonia)	5·6	

Hardness, Clark's scale, 16·5°.

A later analysis, by Dr. S. Rideal (1908), communicated by Mr. F. H. Anson.

Total solids	46·96
Chlorine	3·35
Albuminoid ammonia (none free)	·001
Nitrates, as nitrogen (no nitrites)	·492
Oxygen consumed	·006
Lime	15·68
Magnesia	1·8

Hardness 27·4 = 19·2° Clark's scale.

From the results of chemical and bacteriological examination he is of opinion that the water is of "excellent quality, being remarkably free from organic matter, and, with the exception of the hardness, suitable for all purposes."

Woolwich. Well in the Dockyard. (See p. 218.)

By Dr. W. R. Smith, 1892. In grains per gallon.

Total solid matter, dried at 120° C.	131·3
Loss on ignition, after re-carbonating (organic)	5·
Total mineral matter (inorganic)	126·3
Combined chlorine (equal to common salt 82·9)	53·5
Nitrogen as nitrates	·5
Ammonia	·67
Albumenoid ammonia	·073
Oxygen required to oxidise the organic matter	·273

Hardness 16·3°. Colour in 2-foot stratum yellow. Suspended matter very obvious, turbid.

A highly polluted water, totally unfit for drinking-purposes.

Wouldham.

Four shallow Wells. December 26th, 1868.

1. New well, Provident Place. 2. Parish pump. 3. Mrs. Pye's pump, in the square. 4. Langford's pump.

Rivers Pollution Commission. Sixth Report, 1874, p. 84.

In parts per 100,000.

	1.	2.	3.	4.
Total solid impurity...	53·48	56·32	81·4	88·86
Organic carbon	·148	·079	·14	·125
Organic nitrogen	·071	·051	·077	·074
Ammonia	·003	·001	·001	—
Nitrogen as nitrates and nitrites	1·504	2·3	3·536	3·245
Total combined nitrogen	1·577	2·352	3·614	3·319
Chlorine	4·57	4·47	11·91	11·62
Hardness, temporary	16·2	20·6	20·1	22·8
„ permanent	18·7	18·3	27·5	21·5
„ total	34·9	38·9	47·6	44·3

Two deeper Wells.

Same authority, p. 101. Repeated p. 293. In parts per 100,000.
5. Cement Co.'s Works, December 26th, 1868. 6. New well in Chalk-pit, April, 1869.

	5.	6.
Total solid impurity	30·	25·98
Organic carbon	·079	·067
Organic nitrogen	·051	·024
Ammonia	·002	·001
Nitrogen as nitrates and nitrites	·834	·605
Total combined nitrogen	·887	·63
Chlorine	2·23	2·1

5. Hardness, temporary 14·9, permanent 7·4 ; total 22·3.
6. „ „ 13·9, „ 6·4 ; „ 20·3

On p. 412 of the *Report* are the following remarks :—" All the samples contained a large proportion of organic nitrogen," and the waters of Nos. 3 and 4 have been " polluted to an extent which would be produced if one third of their volume had been derived from average London sewage."

" All the samples are to be condemned as unsuitable for domestic use ; but the parish pump, Mrs. Pye's pump, and Langford's pump ought to be at once closed, as the domestic use of water from these sources must be attended with great risk to health. The water from the new well in Providence Place was but little better, but that from the Wouldham Cement Co.'s Works and the new well in a chalk pit are of fairly good quality."

Wye. AGRICULTURAL COLLEGE. (From Folkestone Beds. See p. 219.)

By Mr. COUSINS. *Journ. S.E. Agric. Coll.*, No. 1, p. 19 (1895).
Total solids 39·7.
Hardness 23·8, permanent 13·4, temporary 10·4.
Analysis of solid residue.

	Parts per 100,000
Silica	1·5275
Oxide of iron ...	·63
Phosphoric acid ...	·014
Chlorine	3·3
Sulphuric acid ...	3·914
Alumina	·2935
Potash	·5934
Soda	7·3321
Magnesia	1·187
Calcium carbonate	20·93
Nitric acid ...	·27
Total ...	39·995

Another analysis differs slightly.
Made and communicated by Mr. C. **Ekin**, **1899 ?**

Silica	16·75
Ferric oxide	5·32
Aluminium oxide	4·7
Calcium	69·01
Magnesium	11·92
Potassium	10·11
Sodium	23·66
Sulphuric radicle (SO_4)	69·94
Nitric radicle (NO_3)	4·32
Carbonic radicle (CO_3)	106·53
Chlorine	31·99
Deficiency (organic matter, etc.)	31·75
Total solids ...	386·
Ammonia	·2

Parts per million.

Hardness, Clark's scale, temporary 8·75°, permanent 5·95° ; total 14·7°.

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MISCELLANEA AND ADDENDA.

It is convenient to give here various notes that could not well be placed in the earlier part of the Memoir, or which by accident have been left out, as well as information that has come to hand too late to go in the proper place. The first entry should have gone on p. 17, but was overlooked. Headings 1 to 5, or 6, deal with water from the Chalk, and 9 chiefly so.

1. *The Chalk Water System.*

The paper with the above title, by Mr. J. LUCAS[1] is based on observations extending over four years, on the Chalk-tract of Kent and Surrey between the Wey and the Darent. In it he has given a lengthy table showing the height and depth of many Chalk-wells in the parishes of Chelsfield, Cudham, Downe, Eynsford, Farnborough, Halstead, Kingsdown, Orpington, Otford, St. Mary Cray, Shoreham and Wrotham, together with the depths to water and the temperatures of the water, in the years 1874-6. Also a Hydrogeological Map showing the Water Contours on the Chalk Water System, at a minimum-epoch, at 150, 175 (in part) 200, 250 and 300 feet above Ordnance Datum, as well as the line of abutment of the plane of the minimum water line upon the Chalk Marl. Also Hydrogeological Sections across the Chalk Water System between the Darent and the Mole, one of which refers to Kent (Chevening, Chelsfield and St. Mary Cray).

2. *Basin of the Dour.*

Mr. H. E. STILGOE has lately made a notable addition to the literature of Kent water in a paper "The Dover Watershed and Water-Supply" contributed to the Institution of Civil Engineers. He kindly allowed me to see the MS. of this, from which much of the information on p. 122, and some also on p. 33 was extracted. Through the kindness of the Secretary, Dr. J. H. TUDSBERY, I have just had a proof of the paper (July), which will be published shortly. Mr. STILGOE also alluded to the subject in his Presidential Address to the Association of Water Engineers at Birmingham in June, and of this too I have a proof. The following remarks are derived from these two sources.

The catchment-area of the Dour contains about 17,900 acres, over the greater part of which the Upper Chalk caps the hills, the Middle Chalk being seen on the slopes of the valleys.

The underground water of about 1,740 acres, at the western end, flows away from Dover, and that of about another 1,230 acres flows eastward to the sea. The effective area, therefore, is 14,930 acres.

With a rainfall of 30 inches a year we have 27,840,360 gallons a day. Allowing a percolation of 43 per cent. the result is 11,971,354 gallons a day. Of this there is pumped from wells 4,698,200 gallons a days, as follows :—

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[1] *Proc. Inst. C.E.* 1877, vol. xlvii.

Dover Waterworks	1,700 000
„ Castle	36,000
„ Western Heights	168,000
„ Priory Station	167,000
Buckland Paper Mills	1,627,200
Capel-le-Ferne (Lower Standen, Folkestone Waterworks)	1,000,000

[It is interesting to note how large is the amount taken for private supplies, that is those other than public waterworks, the total of four wells only (and there must be many smaller wells) being but 1,800 short of two million gallons a day.—W. W.]

The Drellingore Nailbourne (see p. 56) is noticed at some length, and the effect on it of the pumping at the Folkestone Works is alluded to, the flow lasting only for 17 days on the one occasion that has happened since pumping began (Dec. 22, 1903 to Jan. 7, 1904), whilst in the winter of 1896, 7, with a lower rainfall, it lasted for about three months.

Two springs (Lydden Spout and that near the Convict Prison, see pp. 32, 33) account for less than 367,329 gallons a day in addition to the above wells; but others on the foreshore near Dover Castle and in the Middle Chalk in the inner harbour (met with when this was deepened) will add more.

The Upper Chalk absorbs rain very rapidly and parts with it very slowly, as does the Middle Chalk, which is closer in texture and has more defined channels. The Lower or Grey Chalk is hard, practically impervious and with fissures even larger than those in the Middle Chalk, but not so numerous. Anyone wading along an adit in the Middle Chalk must notice the water pouring out of the fissures which are cut. The impervious character of the Lower Chalk [? Chalk Marl] was shown in sinking the shaft for the Channel Tunnel, the work not being hindered by percolation of sea-water, either in the shaft or in the heading, under the sea.

The plate shows the water-level of wells in the Alkham Valley and three geological sections, with the sites of wells, from Folkestone to Whitfield, from North Court (Swingfield) to the Coast at Hougham, and from Wickham Bushes (Lydden) to Shakespeare Cliff.

Allusion is made to the destructive action of Dover water on a cast-iron pump-bucket at the Waterworks, which was owing to the iron itself. Mr. T. Kennedy suggested that the cause was "electric action caused by free carbon forming a positive to the negative of iron," and on analysis this iron was found to contain much more combined carbon than a compound of four Scotch brands did, and also an excessive amount of silicon. Some time before seeing the MS. of Mr. Stilgoe's paper, Mr. F. L. Ball showed me, at the East Kent Waterworks, about $3\frac{1}{2}$ miles from those of Dover (see East Langdon, p. 123), a like occurrence of curiously pitted iron, which I suggested was worthy of investigation. See also p. 141.

3. *Zones of the Chalk.*

In July 1908 Mr. M. BURR made a contribution to the study of Chalk-water, which is of much value as it is based on information from Dr. A. W. ROWE, whose admirable work, in dividing the Chalk into Zones by means of the contained fossils, is well-known to geologists.

This detailed work has been carried on for many years, starting in Kent, and Mr. BURR is to be congratulated in getting Dr. ROWE to apply it to the question of the water-bearing character of the various zones in the eastern part of Kent.[1]

The following remarks refer to the various zones, beginning at the top.

"As the top zones of the Upper Chalk are very much fissured they act as a sponge with great powers of absorption. The *Marsupites* and *Uintacrinus* Chalk is especially porous, and consequently swallows up water with astonishing rapidity. As this zone does not attain a great thickness, the line [plane] of saturation rarely rises to its base, and consequently it is as a rule dry."

"The zone of *M.* [*Micraster*] *cor-anguinum* is very thick, and the line [plane] of saturation in most places occurs in this zone, the upper part traversed by very numerous and regular joints. Water is generally to be met with in the joints and flowing along the bedding planes and beds of flints." Its outcrop being wide "most wells in East Kent are begun in this zone and attain their water before getting through it."

"The zone of *M.* [*Micraster*] *cor-testudinarium* is very much harder . . and is less jointed, but it is by no means free from water. The great irruption at Snowdown [Colliery] occurred in this zone," at the depth of 275 feet.

"The zone of *Holaster planus* differs but little in its physical characters from the preceding. Both these zones are essentially water bearing."

"The Middle Chalk is much richer in marl than the Upper Chalk, and consequently less porous."

"The zone of *Terebratulina gracilis* contains numerous marl seams." In the Tilmanstone Shaft it was found "that the deep-seated chalk of this zone differs in certain physical characters from the familiar chalk of the same zone . . in the cliff sections. Compared with the Upper Chalk, this zone and the almost indistinguishable upper portion of the zone of *Rhynchonella cuvieri* are relatively impermeable, for though we find water travelling in (? along) the marl seams and fissures, these [the fissures] are far less numerous and less open than in the Upper Chalk."

About the middle of the *Rh. cuvieri* zone there are occasional hard bands. Lower down hard bands are more frequent and the basal 30 or 40 feet forms a hard massive rock, correlated with the Melbourn Rock.

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[1] Development of S. E. Coalfield, Ed. 3.

Below this come the Belemnite Marls, characterized by *Actinocamax* (*Belemnitella*) *planus*, greyish or yellowish in the cliffs, but of a different appearance in the pits [shafts?], "and only containing such water as is admitted . . from above through fractures."

"The massive zone of *Holaster subglobosus* is waterproof. At the top of the underlying zone of *Ammonites varius* is a bed, only 3 feet thick, soft and marly . . probably the same that throws out the picturesque spring called 'Holywell,' near the Sugarloaf Hill, Folkestone, and other springs at the foot of the escarpment . . the rise of this bed from the sea is marked by a perennial spring, the famous Lydden Spout."

An Addendum says:—"When the above was written, there were only three pits [coal-pits] which had passed through the zone of *Micraster cortestudinarium*," Snowdown, Tilmanstone No. 1 and Guilford No. 3, "which was standing with water in it in the zone of *Holaster planus*."

"The Gabrielle Pit at Tilmanstone has reached the zone of *Holaster planus* without the use of a pump, having thus passed through the most dangerous part of the chalk into the firmer and drier zones beneath."

4. *Amount of Water pumped from the Chalk in North-western Kent.*

The amount of water taken by the Metropolitan Water Board has already been noticed; but up till very lately we have been without any definite information as to the amount otherwise taken, having only the knowledge that the many large manufactories etc. must use a very large quantity. Mr. CLAYTON BEADLE has, however, taken up this subject also and given us an account of his work, from which the following remarks are got.[1] He says that "with local assistance I was able to obtain figures for all the pumping within an area formerly administered by the Kent Company" (= the Metropolitan Water Board) . . In this area there are about 80 industrial concerns, &c., which derive their water supply from wells. These consist of breweries, paper mills, engineering works, chemical works, public baths, cement works, wharves, electrical engineering works, municipal undertakings, asylums, flour mills, &c., in addition to wells used for pumping water for public supplies" (not including the Metropolitan Board's Works).

"Where possible the figure taken is not . . for one day's measurement, but an average figure throughout the year. In many works . . a very close figure was obtainable. In other cases the amount of water can only roughly be computed."

"The returns have been taken with the object of discovering what was the probable amount pumped by private concerns at the time of Lord Balfour's Commission, and what the amount ten years after."

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[1] *Journ. R. Soc. Arts*, vol. lvi., no. 2895, 1908, pp. 660—662, 664—667.

From the elaborate tables given the following general result is compiled, the amounts being in gallons a day.

A. In the area of the Kent Water Company within the County of London.
B. In the area of the Kent Water Company along Thames riverside and Lowlands below the County of London.
C. In the area of the Kent Water Company in the Watershed of the Cray.
D. In the area of the Kent Water Company in the Watershed of the Darent.
E. In the Watershed of the Darent outside the area of the Kent Water Company.
F. In the area of supply of the Gravesend Water Company and bordering the north-eastern boundary of the area of the Kent Water Company.

Districts.	Lower Limit.	Higher Limit.	Increase since Lord Balfour's Commission.
A. 21 entries	2,006,600	2,136,700	366,400
B. 29 entries	16,188,600	16,740,400	10,420,100
C. 8 entries	1,679,000	2,032,700	326,900
D. 19 entries	2,319,900	2,431,900	539,100
Total, in area of Kent Company...	22,194,100	23,341,700	11,652,500
E. 4 entries	204,400	204,400	300
F. 6 entries	882,400	1,282,400	90,000
Grand Total	23,280,900	24,828,500	11,742,800

"The aggregate amount pumped is without doubt greater than . . the lower limit . . and probably not so high as . . the higher limit."

"In arriving at the above figures a deduction had to be made in some cases . . for infiltration of river water . . for soakage back into the soil, as in the case of brick and cement makers."

"The figures so deducted make up in all upwards of three millions of gallons."

It is very satisfactory to have this matter put beyond the domain of mere surmise and brought into that of knowledge. The result is somewhat surprising, for though one knew that the amount pumped by others than the Water Board was very large, one hardly expected it to exceed that of the Water Board. Of course the many small private supplies are not reckoned; but probably they would not make a serious addition. Anyhow it is clear that the Metropolitan Water Board is not chargeable with half the amount taken from the Chalk of North-western Kent; moreover some small part of its supply is really derived from Surrey.

How difficult it is, even for Royal Commissions, to come to definite conclusions as to underground water-supply, the following quotation shows:—"When the amount pumped for 1903 by the Kent Water Company is added to that of the manufacturers, the total amount of water pumped within the area of the Kent

Water Company is not less than 40,000,000 gallons per diem. . This is far in excess of the safe limit of 27,500,000 as stated by Lord Balfour's Commission."

Mr. BEADLE concludes his discussion of this subject by alluding to the increased rate of pumping, and suggesting that if it continues the quantity taken "must be far and away above what can be restored to underground supplies from the rainfall, so that . . we shall have to face a check in our industrial development as well as a curtailment in the amount of water that can be drawn from these areas."

From this point of view it is a blessing that there are other water-supplies than those of Kent, that the north-western part of the county is practically connected with the whole Metropolitan system, and that it can share in future developments of that great supply.

5. *Effect of Heavy Pumping.*

A few years ago very heavy pumping was resorted to in a pit close to the edge of the Marsh, in the parish of Swanscombe, over a third of a mile north-westward of Northfleet Railway Station, solely for the purpose of getting chalk below the level of saturation. A letter from Mr. CLAYTON BEADLE (? July 1904) contains the following remarks:—The Springhead stream was dried up till within the last twelve months. This was attributed to the Pumping Station at Southfleet. The Northfleet Chalk and Ballast Company were using powerful pumps, to reduce their water-level by about 40 feet. About a year ago (=1903) their pumps gave out and pumping ceased till within the last month. The Springhead stream filled again; but since pumping has been again started it is getting dried up, and this goes to prove that it was not the Kent Water Company that took the water, but the Ballast Company.

That Mr. BEADLE's conclusion is in the main right is fairly clear, for whereas the Southfleet Pumping Station was taking only about a million gallons a day (much less than the usual flow of the spring) some seven millions were being pumped at the Chalk-pit.

Considering the nearness of the tidal water of the Thames it seems strange that salt water was not very largely drawn in. On the day when I visited the place, at the north-eastern part of the quarry-face, at the bottom part, where it was damp, there were freshwater-shells (*Lymnea*) some little way up the vertical wall. But Mr. BEADLE gives the proportion of river-water as more than one seventh (see p. 376). On the other or southern and western sides of the pit, however, and along the bottom there was good evidence that impure water, from the adjoining Northfleet Paper Works (also in Swanscombe parish) was being drawn in, the water being of various and vivid colours, and holes dug in the chalk having a strong smell of sulphuretted hydrogen.

It should be remembered that the exhaustion by pumping was added to by the Paper Works, to the extent of more than a million gallons a day and that there was other heavy private pumping in the neighbourhood; so that it seems rather hard to have laid the damage on the comparatively small amount taken by the then Kent Water Company.

The marshes by the side of the stream above the railway were dried up and had an appearance unlike that usual in damp alluvial ground.

I believe that the pumping for the purpose of working the Chalk below Ordnance Datum has been lately abandoned (though it went on in 1907) and as there is plenty of dry chalk in the neighbourhood it seems wrong that good water should be pumped to waste, as was the case. The chalk-pits hereabouts are worked down to water-level, and that should be enough. The Springhead water is noticed on p. 39.

A temporary effect on the water-level of wells is sometimes brought about by works that have to be made below water-level. As an example I am told by Mr. R. H. **Chandler** (1907) that in making a trench for a new sewer parallel with the railway between Belvedere and Abbey Wood Stations, two wells about 50 yards off had their water lowered a foot to 1½ feet.

6. *Old Method of Raising Water.*

An interesting survival of an old method of raising water has been recorded lately. At Culand, near Snodland [?Kewland, Burham] is an Elizabethan house with "an old cage wheel formerly used for drawing water from a well some one hundred and twenty feet deep. The wheel is, or was, worked by a man getting inside and walking rapidly forward. The wheel is about thirteen feet in diameter, and its rim about two feet wide."[1] The best known arrangement of this sort perhaps is that at Carisbrook Castle, in the Isle of Wight, where the wheel is worked by a donkey.

7. *Magnetization of Boring Rods.*

In 1886 I heard from Mr. W. H. **Shrubsole**, who was then living at Sheerness, that he had visited occasionally a well then in progress at Neats Court, in Sheppey. He says: "the foreman told me that he had been anxiously looking in this and other borings in this part of Kent, for years past, for traces of *lodestone*, which he said he was certain must be in the London Clay, because the rods always became magnetized. The test he applies is to rub the blade of a pocket-knife on one of the rods in use. When this has been done the knife will attract and hold needles, nails etc., with ease. . . . I gathered that he had found it only occurred in the London Clay." This letter was sent as corroborating remarks of a like nature made in a paper "On some Borings in Kent" in regard to a well at Frindsbury, which are reproduced on page 143. The following remarks are taken from the paper in question[1]:—"The only other instances of a like occurrence that I have heard of come from America. Mr. G. E. **Broadhead** has recorded that "in boring to the depth of 833 feet, the drill was often observed to be highly magnetized, but after that depth no further influence was observed" (*Trans. Ac. Sci. St. Louis*, vol. iii., p. 221) and in a "Report on the Artesian Wells of Denver" (*Proc. Colorado Sci. Soc.*, vol. i., p. 86, 1885). Mr. F. **Chisholm** says: "Upon the subject of the so-called magnetic water, it is scarcely necessary to say that water cannot be magnetic. The magnetism observed is located in the casings, and is due to the magnetizing of the steel drill by friction and pounding, and this magnetism is communicated to the casing during the passage of the drill when lifted and lowered." I cannot call to mind any later remarks on the subject.

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[1] *Rochester Naturalist*, 1907, vol. iii., no. 98, p. 488.

8. *Supply of Water to Shorncliffe Camp.*

An interesting Report of 1855 on the former supply has been published, and the chemical analysis from it are given on pages 275, 294. It may be well here to notice the gist of the Report.[2]

"The supply would seem to be quite as abundant in the lower as in the upper strata," the former being from springs in the Hythe Beds, the latter from wells in the Folkestone Beds. "In either case care should be taken to preserve the supply from surface contamination; (a point which struck me as not having been attended to in the construction of the wells in the camp.)"

"It was the general opinion of all with whom I communicated at the camp, that although the water at Shorncliff was bad, it was by no means the only or principal cause of cholera. . . I could not learn that any single case of cholera at the camp could be traced directly to the influence of the water."

"Many other influences were in operation. The habits of the men were singularly prejudicial to health. (He gives a choice collection of them) . . whilst the latrines . . were so placed as to affect the air of the whole camp." It can hardly be said that they did these things better then! The present supply is taken from the Folkestone Water Company.

9. *Infiltration of Salt Water.*

The border of Kent from Deptford, on the north-west, to the Nore, is the tidal Thames, and from the Nore eastward and then southward to Denge Marsh, the sea. It is clear, therefore, that the greater part of the county-boundary is at the edge of salt or brackish water and it follows that wells within a short distance of the Thames or the sea are open to the risk of drawing in salt water, wherever over-pumping is set up and the geologic formation from which the water is got crops out in the water near by.

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[1] *Quart. Journ. Geol. Soc.*, 1886, vol. xlii., p. 33.

[2] L. **Blyth.** *Papers Corps R. Eng.*, ser. 2, vol. v., p. 75 (pp. 77, 80 here referred to.)

Some occurrences of this sort are noticed under the places at which they happened (see Index). Of course where pumping is not carried to such an extent as to lower the water in a well below sea-level, no ill effect results though the water-level may vary with the tide, a mere matter of hydraulic balance, freer exit being given to the water at low than at high tide.

Some fairly old records of infiltration of salt water into wells have been made by well-known engineers, and notes of two of these follow.

Mr. R. W. MYLNE has noted a peculiar case. He says: "A singular circumstance happened in cutting through the Chalk hills, for the formation of a tunnel for the Thames and Medway canal: that operation had the effect of draining the whole of the fresh water from the wells within the range of a mile, and substituting salt water in those wells."[1] This was again alluded to by Mr. F. BRAITHWAITE who also remarks that "all the wells in Ramsgate, which have been recently deepened, on account of the falling off of the supply of water, are rendered useless by the infiltration of sea-water."[2]

Of late years the subject has been taken up by Mr. CLAYTON BEADLE, whose remarks will now be given. "On the Marshes between Plumstead and Erith water pumped from the ballast 250 ft. from the Thames is almost wholly derived from the Thames. Wells sunk to a depth of 300 ft. with a shield for the first 200 ft. in this locality yield very bad water and at a depth of 180 ft. with a shield reaching down 90 ft. the water pumped from the chalk contains 20 °/₀ of river water. The brackishness of the water is found to be increased as the levels are depressed by pumping. The effects of infiltration may extend half a mile or more inland as the levels are lowered, rendering the water . . unfit for drinking purposes."[3]

He has communicated the following information which he had in July 1904 from Tolhurst's Cement Works, Northfleet. The water from a well 50 yards from the river-wall seemed to be about half river-water. That from a well 300 yards from the river-wall was brackish, though it was not so when the well was dug. Water from the boilers, got at about 1000 yards from the river-wall was very good.

Mr. BEADLE has lately made some lengthy remarks on the subject[4] "primarily for the purpose of ascertaining how much water would, in all likelihood, percolate from the Thames, if the river were permanently held up to high-water mark, as would be the case if the Gravesend Barrage" were made, and he goes on "to review the various conditions which tend to promote or retard infiltration under the existing circumstances, as well as to bring forward any evidence . . to show the presence or absence of Thames water in the neighbourhood of the river."

The river-walls are water-tight, but not being carried to any depth into the marshes any permeable beds under the marsh land are not shut off from the river. "The natural water level in the marsh land approximately corresponds with the 'mean tidal level' in the river." This would be a serious matter were the Barrage made, and the level of the river kept high: amongst other things the level of the water in the Chalk-pits near the Thames would rise and so lessen the amount of chalk that could be got.

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[1] *Trans. Inst. C.E.*, 1842, vol. iii., p. 233.
[2] *Proc. Inst. C.E.*, 1855, vol. xiv., p. 509.
[3] *Ann. Rep. Underground Water Preservation Assoc.*, 1903, pp. 2, 3.
[4] *The Port of London and the Thames Barrage*, 1907, pp. 81—100.

He then refers to my "Chalk Area Maps" (see p. 14) and from them has constructed the following table (corrected from reproduction in *Journ. Soc. Arts*, no. 2895, p. 667). "Water could rise up out of the chalk where bare, or covered by 'permeable' beds, but less readily where covered by 'mixed' beds, and not at all where covered by 'impermeable' beds." He concludes that "if the 'saturation-level' rose in the chalk by infiltration from the river, it would not be impeded from overflowing the land and finding a common level with the river water." I should think, however, that the mixed beds would considerably retard such a rise of the water.

Areas, in square miles, of Permeable, Impermeable and Mixed Beds (in the Thames Marshes from Gravesend to Greenwich).

	Area below H. W. M.	Contributing Drainage.	Area below H. W. M.		Area above H. W. M.		
			Permeable.	Mixed.	Permeable.	Mixed.	Impermeable
Swanscombe Marshes ...	·5	—	—	·5	—	—	—
Dartford and Stone Marshes	1·8	10·	—	1·8	8·	1·	1·
Between the Cray and the Darent	·3	·5	·1	·2	·5	—	—
Crayford Marshes ...	·6	2·	—	·6	1·	1·	—
Erith Marshes, etc. ...	2·6	6·	·1	2·5	1·3	3·9	·8
Plumstead Marshes ...	2·3	—	—	2·3	—	—	—
Greenwich Marshes ...	1·1	2·5	—	1·1	·8	1·7	—
Total	9·2	21·	·2	9·	11·6	7·6	1·8

Mr. BEADLE says: "We have ample evidence of the passage of river water into the chalk from the analysis of the water in the wells and their rise and fall. The river water appears often to come in just in proportion as the difference in level increases." I would point out, however, that rise and fall of water in a well with the tide does not imply that salt water gets into the well. It is dependent on the checking of the outflow of fresh water as the tide rises and the reverse action as the tide falls. He continues "the salt found in the water of these wells cannot be (beyond a mere trace, which is allowed for) from any source other than the river"; but this hardly holds altogether for very deep wells, the water of which is often somewhat salt.

He gives the following "instances of infiltration of Thames water into large wells used by industrial concerns, arrived at by comparing the composition of the well water with that of the nearest Thames water," partly taken from a Report made in 1903, but with additions, which I now put with the other entries. The figures in colums 2 and 3 are grains per gallon.

Place	Well-water	Mean for River-water	Proportion of Thames-water in Well-water
Now Cross	90	50 to 500	Say 25 per cent.
" "	54	100 to 400	About 10 " "
Charlton	29	100 to 700	Say 7 " "
"	32	200 to 500	About 8 " "
Woolwich...	37	150 to 800	" 7 " "
Erith Marshes	250 to 1000	250 to 1000	Nearly all.
" "	175	250 to 1000	Say 25 per cent.
" "	40	250 to 1000	" 6 " "
Northfleet	175 to 250	700 to 1400	" 15 " "
"	34	700 to 1400	" 5 " "
"	175	700 to 1400	About 16 " "
Dartford	—	—	" 5 " "

He says that in evidence for the Metropolitan Water Board Arbitration "in taking stock of the amount of water pumped by various concerns within the area of the Kent Water Works Company, I was obliged to make deductions for the amount of infiltration from the River Thames. In the aggregate I found it necessary to deduct about 3 million gallons per diem for the water percolating from the river to the wells existing on the lowlands . . between Deptford and Swanscombe."

Still later, indeed after this Memoir was in print, Mr. BEADLE has made further remarks on the subject,[1] with notes on various tidal wells not referred to in the previous work, as follows (for Kent):—

"Well about 200 yards South of Erith Pier, ebbed and flowed with the tide; containing double the amount of salt at high, as compared with that of low level."

"At the Northfleet Town Cement Works the water level was 14½ feet at low tide, and 6 feet 4 inches at high tide."

"Certain ditches below Erith . . fill and empty with the rise and fall of the tide."

"A well sunk for hospital ships at Crayford Ness yielded very brackish water, and had to be abandoned."

"Water pumped from the pit of the Northfleet Coal and Ballast Company (see above p. 371) was found to be brackish, and the brackishness increased with the reduction of levels; the amount of river water entering amounting to over 1,000,000 gallons . . out of a total of 7,000,000 per diem pumped."

A well at Gravesend "gave out in 1902, up to which time the water was very pure, and had no trace of brackishness. The well was deepened to a depth of 175 feet, at which a very copious supply of water was obtained, but it was so brackish that it could not be used in a laundry."

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[1] *Journ. R. Soc. Arts*, vol. lvi., no. 2895, 1908, pp. 658—660, 668.

He says of these wells generally that they "rise and fall with the rise and fall of the tide, either corresponding with the tide or lagging behind the tide according as whether the percolation from the Thames is free or sluggish, and depending to some extent on the distance of the well from the river. Furthermore, some of these wells are found to be very brackish as the result of ingress of river water, some of them being more brackish at the high level (of the tide) than at the low."

"In one notable case large quantities of water are pumped from the ballast to a distance of 200 feet from the river, the water being practically the same composition as the river water."

"The lower reaches of the Thames are in many places exposed to the bare chalk or to other permeable strata. Water pumped from the chalk in the low-lying lands, even when shielded for the first 100 feet, is found in places to draw large quantities of river water."

"At many of the works which we visited on the low-lying lands we found that the well water had been condemned for drinking purposes on account of its brackishness, although copious supplies could be obtained for manufacturing purposes; in other places great trouble resulted in steam raising in consequence of the brackishness of the water."

"In order to form some idea of the permeability of the alluvium and valley drift in this low-lying land, I took particulars of 154 trial borings, and classified the surface deposits under five headings in ascending order of permeability. From a series of tables I arrived at a permeability of 40 per cent. in comparison with freely permeable beds."

"The conclusion appears to be, that with increased pumping on these low-lying lands increased percolation will result, and consequently an increased proportion of brackish or river water will find its way into the wells. . . This conclusion is what one might expect from the fact that a large part of the lower Thames flows over permeable beds, which beds communicate inland to low-lying marshes, and the scour of the tide keeps these permeable beds from being pugged by the deposition of river mud."

10. *Pollution of Water.*

Several cases of the pollution of water have been noticed in the accounts of various wells (see Index), and others, especially from infiltration of salt water, have been referred to just above. There are, however, some other cases worthy of note, the first being a careful piece of investigation "On the Pollution of Wells in Lower Greensand,"[1] made many years ago by the Rev. J. H. Timins, who was vicar of West Malling for 50 years. Although this refers to a past state of things it is still of interest as showing the troubles that may occur in a good sized village without a public supply. Moreover it is published in a journal, old numbers of which are not easily to be seen, so that a partial reproduction is the more justified.

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[1] *Sanitary Record*, 18 1. new. ser., vol. ii., pp. 413—415.

After a short description of the character of the local divisions of the Lower Greensand Mr. TIMINS, who was an accomplished chemist, goes on to say :—

"The object of this paper is to show the nature of the pollutions to which well-water in these strata is liable, and the extent to which organic matters passing through the soil become innocuous by oxidation, by determining the amount of past and present animal contamination of the wells and springs in the Kentish rag districts of West Malling, within an area extending 6,000 ft. from north to south, by 1,000 ft. from east to west, and of the adjoining parish of Offham; and by a similar examination of wells in the middle beds of the lower greensand north-west of Malling, and in the upper beds near the Wrotham Station at Borough Green."

The results of the analyses, all but one by himself, are given in a table, dealing with 43 wells or springs, in some cases on two or more days. Chlorine, ammonia (free and albuminoid) and total combined nitrogen are the matters recorded.

A geologic section is given along the line of road through West Malling and St. Leonards, showing some unevenness in the top of the Weald Clay. This has led "to the formation of subterranean currents in the water-beds. When the natural reservoirs on the Weald clay are tapped, the water rises in the wells from 10 to 40 ft.; and when, as is commonly the case, an abundant supply of water is obtained without going down to the Weald clay, the water is found to flow into the wells from one or other of their sides, and sometimes to pass through them in a continuous stream. In consequence of this subterranean flow of water, wells are sometimes polluted at a considerable distance from the source of their contamination; and other wells undergo little or no pollution from cess-pools placed within a few feet of them."

In dealing with the analyses of the waters the following remarks are made, as to polluted sources, the Nos. being those of the wells in the paper :—

2. "The quantity of chlorine . . is from five to seven times that of its normal amount, showing extensive pollution by liquid sewage."

4. "The quantity of free ammonia indicates the access of sewage which can have undergone little oxidation by filtration."

8. From a polluted stream. "When the stream has overflowed its banks, water from it has passed, scarcely changed, through fissures in the Kentish rag, into distant wells. . I found two wells thus polluted; one . . 415 ft., and the other 810 ft. west of the nearest part of the stream," the latter being the then town-well, the quality of the water from which "is subject to considerable variation."

15, 16, 17. "The water . . had been much contaminated by organic matter; the greater part of which however had been oxidised during its filtration through gravelly clay and Kentish rag."

18, 19. "Far less destruction of the organic matter by oxidation, and the water . . seriously polluted."

21, 22, 23. "The degree of pollution is proportionate to the number of tenements in the vicinity of each well."

24. "A deep well, with adits, which was made about twenty-five years since to supply the town with water. It is at a low level, and . . no use is made of it." He thinks that with proper precautions a good supply might be got from this.

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[1] Presumably the Atherfield Clay.

26, 27. "As the amount of chlorine was not large the pollution may have been partly derived from stables and dung-pits."

28. "Evidently polluted by sewage to a dangerous extent . . There has been . . much illness in this neighbourhood . . and an epidemic of scarlet fever in the summer of 1877 assumed here an exceptionally malignant and fatal form."

"The results of the examination of wells in the Kentish rag district of Offham . . are very similar to those in Malling."

The conclusions come to are:—

"That the filtration of water contaminated by organic matter through a depth of 60 ft. of sand, or of Kentish rag stone, is ordinarily sufficient for the oxidation of free ammonia, but not for the destruction of organic matter so far as would be necessary to make water, so polluted, organically pure."

"That in the shallow wells in the middle [Sandgate] beds, natural filtration separates solid from liquid matters in water polluted by sewage, so as to make it clear and palatable, but not so as to make it safe for dietetic purposes."

"That the water of wells in the Kentish rag is liable to dangerous pollution, not removable by natural filtration, even at a depth of 100 ft."

"That the water of such wells may be contaminated by polluted streams, running over the Kentish rag, as well as by cesspools, at a distance of many hundred feet . . and, therefore, that, in populous places, where the water supply is derived from wells, any cesspool discharging its contents downwards, and any stream polluted by sewage . . in the Kentish rag districts, should be dealt with as a nuisance dangerous to the health of the neighbourhood."

Mr. C. **Beadle** has said: "The water from one important well from which large quantities of water are drawn, on high land (Dartford Brent) was found by the proprietors to contain typhoid bacillus and condemned for drinking purposes. The pollution . . has been attributed to the use of dried up wells as cess-pits, a practice which cannot be too highly condemned."[1]

Dr. C. H. **Allfrey**, who was Deputy or District Medical Officer in the upper part of the Cray district from 1863 to 1888, tells me (1906) that the water-supply of the majority of the population in the Valley of the Cray was formerly derived from surface-wells, in the porous soils, near cesspools, then the only means of drainage. Another source of impure water was the River Cray, which was polluted almost from its source, from all the villages and paper-mills. There were certain springs yielding pure water. The surface-wells, which gave its name to Well Hill, until recently supplied the village.

Of course with the advent of a public supply these things ceased and there was no excuse for the use of polluted water. Were it proved that the pumping for that public supply was the chief cause of the lessening of the stream (see p. 62) the question arises whether it is better for the water to be used for that supply or for augmenting the stream.

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[1] *Ann. Rep. Underground Water Preservation Assoc.*, 1903, p. 3.

Dr. F. St. G. Mivart, in pp. 3, 4 of his "Report . . on the General Sanitary Circumstances and Administration of the Hollingbourn Rural District, 1908," says that there has been a great advance in the matter of the water-supply, the Mid Kent Water Co. having mains in the district; but he goes on to remark as follows:—

"The water supplies of the village of Leeds especially need attention. At Upper Street, Leeds, a number of wells are near to deep, open-jointed brick cesspools, which are apparently disused wells. It is highly probable that the water thus obtained for drinking will be found contaminated, and at any time an outbreak of serious illness might occur."

At Lenham several wells were seen in a like position. "At the 'Chequers Inn' the well is only a few feet from an open-jointed brick sewer which . . was, at this point, blocked, and on being opened found to be full of decomposing filth."

"In Harrietsham, Hollingbourn, Weavering Street, Boxley, Headcorn, and elsewhere, wells were seen, the surroundings of which are such that the water must be regarded with suspicion."

"In some localities there is still actual scarcity of wholesome water," although in some cases a supply could be got from the Mid Kent Co.

11. *Additional Wells.*

Goudhurst. Near Railway Station. For the Cranbrook Water Company.

Communicated by Mr. G. H. Perryn.
137½ feet above Ordnance Datum.

		Thickness.	Depth.
		Ft.	Ft.
Sandy soil		30	30
[? Ashdown Beds]	Clay	7	37
	Sand-rock	11	48
	Clay	2½	50½
	Sand-rock (with ½ in. of Lignite)	13½	64
	Clay to sand-rock	13½	77½

The first water (50 gallons a minute) was found beneath the uppermost clay. The second water (260 gallons a minute) was found beneath the second clay.

When the lowest sand-rock was reached the yield was 500,000 gallons in 24 hours.

A boring was afterwards put into the lowest sand-rock, and lined to exclude the top water.

Hawkhurst. Near Lightfoot Green, about a mile N.W. from Highgate. For the Cranbrook Water Company.

Communicated by Mr. G. H. Perryn.

Well, about 60 feet deep, in Tunbridge Wells Sand, with about 100 yards of headings. Yield, when finished in the summer of 1897, 188,000 gallons in 24 hours. It decreases very much every year, starting about October, until about the beginning of January, when the water apparently returns.

Tunbridge Wells. Culverden Brewery. Continued from page 209.

From Messrs. Isler & Co.

		Thickness.		Depth.	
		Ft.	in.	Ft.	in.
[Ashdown Beds, 198½ feet]	Previously described down to	—	—	403	0
	Light-coloured mottled clay ...	0	2	403	2
	Very hard light-coloured rock...	48	0	451	2
	Brown mottled clay	0	6	451	8
	Hard light-coloured clay-rock...	9	4	461	0
	Shaly rock	1	0	462	0
	Blue mottled clay	7	6	469	6
	Very hard light-blue rock ...	23	2	492	8
	Extra hard light-coloured rock	10	1	502	9
	Blue clay-rock	1	11	504	8
	Light-coloured sand-rock ...	1	0	505	8
	Hard blue clay-rock	2	3	507	11
	Light-coloured sand-rock ...	11	5	519	4
	Blue clay-rock	0	11	520	3
	Light-coloured rock	1	6	521	9
	Light-coloured sand-rock ...	1	0	522	9
	Grey rock...	1	3	524	0
	Light-coloured sand-rock ...	1	0	525	0
	Grey rock...	1	9	526	9
	Mottled clay and sand	2	3	529	0
	Light-coloured sandstone ...	16	0	545	0
[Fairlight Beds, 272 feet]	Shaly clay and sand	5	0	550	0
	Blue shaly clay	4	0	554	0
	Sand and clay-rock	7	0	561	0
	Light-coloured sand-rock ...	4	0	565	0
	Shaly clay-rock	5	0	570	0
	Dark blue clay	5	0	575	0
	Mottled clay	22	0	597	0
	Light-coloured rock	2	0	599	0
	Mottled clay	27	0	626	0
	Hard blue shaly clay	7	0	633	0
	Sand rock...	61	0	694	0
	Light-coloured sand and clay ...	7	0	701	0
	Hard clay...	3	0	704	0
	Sand-rock...	6	0	710	0
	Shaly clay	2	0	712	0
	Light-coloured sandstone ...	10	0	722	0
	Sand and clay	6	0	728	0
	Blue clay...	2	0	730	0
	Light-coloured sandstone ...	20	6	750	6
	Dark hard clay	4	0	754	6
	Sandstone...	3	6	758	0
	Hard rock...	8	0	766	0
	Hard dark clay	27	0	793	0
	Hard sand-rock	8	0	801	0
	Hard shaly clay-rock	4	0	805	0
	Mottled clay and rock	12	0	817	0
	Very hard dark rock	2	0	819	0
	Light-coloured rock	3	0	822	0
	Brown sand	1	0	823	0
	Light-coloured rock	9	0	832	0
	Hard rock...	9	0	841	0
	Light-coloured hard sandstone	6	0	847	0
	Loamy sandstone...	14	0	861	0

	Thickness.		Depth.	
	Ft.	in..	Ft.	in.
Hard dark sandstone	5	0	866	0
Light-coloured sandstone ...	17	0	883	0
Sand-rock...	12	0	895	0
Light-coloured loamy sand-rock	8	0	903	0
Loamy hard clay with rock ...	3	0	906	0

20 feet of tubes 10 inches in diameter.
240 " " 8½ " " from 20 feet down.
232 " " 7¼ " " " 258 "
125 " " 6 " " " 508 "
150 " " 5 " " " 640 "

Water-level in well 110 feet down; in boring, 220 feet.

Yield about 800 gallons an hour, but increasing rapidly with pumping (August, 1908).

This is the only well-section going deep into the Fairlight Beds in the county. It proves a thickness of 272 feet of them, and, if the last 89 feet are added, of 361 feet, which is in excess of any previous record. The description of the beds, however, leads one to think that some older formation has been reached (? Purbeck). The Fairlight Beds have not been determined in any of the borings, etc., for coal. They must have been found in the Penshurst Boring (pp. 231-234), but in no other is there room for anything but a feeble representation.

Specimens received after the above was printed unfortunately do not help in the classification of the beds. One, from 815 feet, is of fine-grained pale grey micaceous sandstone, and another, from 876 feet, is of a like kind, very fine grained and lighter in colour.

12. *Deep Borings at Cliffe and Frindsbury.*

Whilst this Memoir was passing through the press the Cliffe boring was carried more than 100 feet deeper than is recorded on p. 109, and specimens were sent to the Geological Survey Office by Mr. BALDWIN LATHAM, who also showed me the set at his office.

The result of this deepening was of such interest, besides probably being of economic importance (in a negative way), that I thought it well to make a short communication on it to the British Association, for the meeting in Dublin in September, 1908, which probably will make its way into print before this Memoir is published.

In the Gault the following fossils were found:—*Belemnites, Hoplites (Ammonites) lautus* and *Inoceramus sulcatus.*

It is a little difficult to tell, from the specimens, how far down the Lower Greensand reached; but it certainly came to an end at 1,037 feet. If it goes to this depth there would be a thickness of 96 feet, or more than double of that found at Chatham (see p. 101): it seems likely therefore that this formation may not go quite so deep. The specimen of it consists of brownish-grey sand, not like the ordinary sand of the formation, with pieces of chert.

At 1,037 feet a dark grey clayey rock, which is not calcareous, and so is unlike any of the Jurassic clays, occurs; and I was inclined to regard it as of Palæozoic age. Luckily fossils were found at the depth of 1,063 feet, and they decided the question, *Atrypa reticularis* and *Plectambonites* (*Leptæna*) being determined by Mr. H. A. ALLEN, of the Palæontological Department of the Geological Survey. There are traces of other fossils also.

We have then evidence from fossils that this clayey rock is of *Silurian* age, belonging therefore to a formation older than any hitherto recorded in Kent. Mr. G. W. LAMPLUGH however showed me, at the Geological Survey Office, some of the cores from the bottom part of the Brabourne boring, which seem to be of a like kind.

Unfortunately the water, both from the Chalk and from the Lower Greensand, was too salt to be used. The owners might have been compensated for this had the boring proved a possibility of the occurrence of Coal Measures; but it has done the reverse, having put a northern boundary to the Kentish coal-field in this neighbourhood.

In the account of the boring at the Quarry Cement Works, Frindsbury, on p. 142, it will be seen that a thickness of over 103 feet has been given to the Lower Greensand without the base being reached. In view of the total thickness of only 41 feet at Chatham Dockyard (see p. 101), which place is not far off (? about a mile), this seems excessive.

Further information came to hand in September, when Messrs. ISLER & Co. sent a number of specimens to the Geological Survey Office, ranging from the depth of 850 feet downwards; with some apparently from a little above 850 feet.

Unfortunately there are none from between 813 and 848 feet; but Mr. ISLER'S recollection of the rock passed through is that it was of a bluish colour. Below 848 feet the section is described by him as follows :—

Blue shale and clay, 7 feet, to the depth of 855 feet.
Rock and sands, 33 feet, to the depth of 888 feet.

I examined the specimens with Mr. G. BARROW, Dr. F. L. KITCHIN, and Mr. H. A. ALLEN. Judging from those at and just below 850 feet and from the above description, I am led to think that the bed described as Rock 20¼ feet on p. 142 is really part of the hard clayey series now to be noticed. This would limit the thickness of the Lower Greensand to 83 feet, still more than double the amount at Chatham.

The specimens down to 853½ feet prove to belong to a Jurassic clay. They are hard, grey, calcareous, and with fossils (mostly broken); but the following have been identified in the Palæontological Department.

From above 850 feet (?), *Pecten* (*Æquipecten*) *fibrosus* J. Sow., a clavellate form of *Trigonia*, *Ammonites* (*Perisphinctes*), *Cardium* ?, *Exogyra*, *Ostrea*, *Pinna*, *Thracia* ?.

From 850 feet, *Cidaris Smithi* Wright, *Exogyra nana* J. Sow., *Ostrea deltoidea* J. Sow., and another, *Ammonites*, *Belemnites*, a stout and a slender form, *Modiola* ?, *Perna*.

From 853 feet 9 inches, *Perna* or *Gervillia*.

Dr. KITCHIN and Mr. ALLEN regard the group from the depth of 850 feet as pointing to the Corallian age of the beds, which is of interest, as at Chatham Dockyard the boring seemed to pass direct from Lower Greensand into Oxford Clay. Mr. S. S. BUCKMAN regards the *Perisphinctes* in the top part as a polyploroid form of Kimeridge age.

Below this hard clay (which has been described as rock by the well-sinker, with reason) the boring passed, at the depth of between 854 and 855 feet, into hard oolitic limestone, some fine-grained, with broken fossils in many parts, sometimes slightly sandy, with loose sand at or just below 855 feet (? let down in boring) and with some grey clayey material at about 860 feet. The first set of specimens of these ranged from 855 to 865 feet, and, taken by itself, the appearance of the stone suggests that it belongs to the Forest Marble.

The next two sets of specimens show a continuous, though broken, core from about 865 to 875 feet. The oolitic character continues at first, but after about 3 feet decreases and then soon disappears. From 866½ to 867½ specimens of *Nerinæa* are abundant.

From about 870 feet downward the specimens are somewhat different, being of finer grain and very compact. There is much crystalline calcite and some dark clay (pellets in some cases). Mr. BARROW says that, in its compact character, the lower specimens resemble the upper part of the Great Oolite Limestone of the Bicester district, a view that seems to be confirmed by the resemblance of the overlying rock to the Forest Marble.

The lowest set of specimens, about 6 feet in length, represents the depth from 875 to 888 feet. At 876 feet spines of *Cidaris* occur in great number. Lower down corals occur, with much dark clay, and the rock becomes of a very earthy character and softer. There are changes in the hardness of the stone, which is of a porous and often friable nature. The frequent occurrence of the corals suggests Coralline Oolite; but the presence of the irregular and never bedded patches of clay is unusual. As the rocks, as a whole, are of an abnormal character and the many fossils are badly preserved, the question of their exact age cannot now be settled.

We have then clear proof that the Jurassic clays at the top of the series here are of no great thickness, reaching only 41 or 42 feet. It seems likely that the rest of the series may follow suit; but what may come next beneath, from the Trias downward, is of course doubtful. It is much to be wished that this boring could be continued for exploratory purposes.

13. *Photographs of Bournes.*

During the meeting of the British Association in Dublin, in September, 1908, Prof. WATTS exhibited a set of photographs, by Mr. C. BUCKINGHAM, which illustrate the Bourne-flows in the Little Stour, or Elham, Valley and in the Petham Valley (see pp. 55, 58-60). These views were taken in 1904 and 1905, and in many cases in duplicate, so as to show spots in the valleys both when dry and when the bourne was flowing. They form part of the collection of the Geological Photographs Committee of the British Association, and will join the rest of that grand series in the Library of the Jermyn Street Museum, where anyone interested in geology or photography can see them.

After the above was in type, the following was communicated by Mr. H. E. STILGOE.

Lyminge. ELHAM VALLEY WATER COMPANY. About a mile westward of the Church.

Ordnance Map 289, new ser.; Geol. Map 3.
450½ feet above Ordnance Datum.
Shaft 141 feet, with heading, the floor of which is 125½ feet down.

Chalk	124½	141 feet
Grey Chalk, very hard	16½	

The Company supplies Elham, Lyminge, Postling, Saltwood and Stanford.

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Names of persons are in small capitals.
" " places " " italics, those not in Kent being marked by an asterisk (*)
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